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ABSTRACT

This is a catalog of behavioral objectives for Vocational Automotive Mechanics organized by units of instruction as listed in the State curriculum guide. Each unit contains a suggested outline of content, a goal statement, and general and specific objectives. The units taught are: introduction to the automobile; basic hand tools--fasteners and measuring; general service procedure; engine theory and service; fuel system; lubricating system; cooling system; ignition system; starting system; charging system; diagnosis and tuneup; manual transmission fundamentals; drive line and differential assembly; brake system; suspension steering; and ventilation system. The purpose of each unit is three-fold: to provide a bank of objectives which could be related to task analyses and job descriptions, to provide a bank of test items which could be used in statewide studies of program effectiveness, and to develop materials which could be used in the Behavioral Objectives Organized in a System for Teachers (BOOST) which is both a delivery system for objectives and a computer bank of test items associated with the objectives. (BP)

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Vocational Education Evaluation Project

Behavioral Objectives And Related Test Items
For
Selected Units In Automotive Mechanics

Richard K. Hill, H. Elizabeth Mays, and William R. Williams
Editors

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FOREWORD

The primary objective of the Vocational Education Evaluation Project is to develop a management information system for the planning and programming of vocational education. To facilitate the accomplishment of this objective, the work of the project has been divided into a macro-subsystem and a micro-subsystem. The macro-subsystem is primarily concerned with guidelines and systematic procedures at the state level, while the micro-subsystem is emphasizing the assessing, planning, and programming of individual vocational education programs in local schools.

Direct costs for this project were funded on a 90 percent reimbursement basis by the Division of Vocational Education, State Department of Education, Richmond, Virginia. These funds came from Part C of the Vocational Education Amendments of 1968. The remaining 10 percent of direct costs and all indirect costs were funded by the Research Division, Virginia Polytechnic Institute and State University. The Division of Educational Research and Statistics, State Department of Education, provided the data processing for the Vocational Education Reporting System.

Special gratitude is expressed to the Division of Vocational Education and the Division of Educational Research and Statistics, State Department of Education for their financial assistance and staff support.

The units contained in this catalog were developed for use in the micro-subsystem. These materials are the products of an effort to develop a means of assessing the effectiveness of local instructional programs.

This publication is one in a series of publications of the Vocational Education Evaluation Project. The intent of this series is to inform educators in Virginia, as well as the nation, of the project's work.

Dewey A. Adams, Director
Division of Vocational and
Technical Education
College of Education

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INTRODUCTION

WHAT IS IN THE CATALOG

This is a catalog of behavioral objectives for Vocational Automotive Mechanics organized by units of instruction as listed in the state curriculum guide. Each unit contains a suggested outline of content, a goal statement, and general and specific objectives.

HOW THE UNITS WERE DEVELOPED

These units were developed during summer workshops conducted on the campus of Virginia Polytechnic Institute and State University during the summers of 1972 and 1973. Auto mechanics teachers from throughout the Commonwealth participated. They received instruction on how to develop these materials and then wrote them in workshops. During the workshops, their work was supervised by Dr. Richard Hill and Mr. Randy Williams. At the conclusion of the workshop, the materials were collected and edited by Dr. Hill, Mr. Williams, and Miss Mays.

WHY THE UNITS WERE DEVELOPED

The original intent in writing the units was three-fold: to provide a bank of objectives which could be related to task analyses and job descriptions, to provide a bank of test items which could be used in state-wide studies of program effectiveness, and to develop materials which could be used in BOOST (Behavioral Objectives Organized in a System for Teachers). There is an explanation of BOOST starting on page viii.

HOW TO USE THE CATALOG

How These Objectives Are Written and Organized

A set of behavioral objectives must be comprehensive and specific. It must be comprehensive for planning purposes because the exclusion of any objective might be critical. (For example, if a unit is written on good grooming and all the objectives that relate to understanding why good grooming is important are left off, it might as well not have been started. Surely, someone who understands "how" but not "why" is unlikely to exhibit the behaviors desired when he is no longer restrained by the testing situation.) The objectives must be specific for evaluation purposes because reliable tests cannot be developed if the objectives which determine the questions to be constructed are subject to varying interpretations.

The way objectives typically are written is to attempt to develop one comprehensive set of specific objectives. This approach would yield a satisfactory solution if, in fact, it were possible to do. Since it usually is not, when they are asked to do it, most teachers encounter great frustration. Their usual response is to develop a long list of objectives which require recall of the content to be presented, and little more. Of course, if they were asked if that list of objectives reflected their true intent, they would respond negatively. However, the construction of this first list takes so long that they usually stop there, having little time or desire to continue. This unsatisfactory situation need not continue. This current approach of writing objectives ignores the fact that there really is no need for a set of comprehensive objectives to be specific, nor for a set of specific objectives to be comprehensive. This will be explained in greater detail.

The objectives must be comprehensive for planning purposes. But teachers can plan their instruction at least as well from more general statements as they can from specific ones, and frequently even better. For planning purposes, it should be permissible to use words such as "understand," "appreciate," and "comprehend." So long as the objectives are written so that teachers can communicate with each other with reasonable clarity, further specificity is not required.

The purpose of writing specific objectives is to have a starting point for the development of test questions. But a test is never comprehensive; therefore, there is no need for the specific objectives to be comprehensive either. They only must be representative.

This alternative approach to writing objectives was used in the development of this catalog. Each unit contains one set of objectives which is comprehensive and clear, but not specific, and then another set of objectives which is specific and representative, but not comprehensive. With this approach, the former set of objectives (called general objectives) is written first. The latter set is written by taking each general objective, and writing five to eight specific objectives for each. The specific objectives should cover as many different aspects of the general objective as possible. Their main purpose is to help define and add clarity to the general objective.

The reason for putting limits on the number of specific objectives to be written for each general objective is to help insure representativeness. It is easy to succumb to the temptation of writing a few specific objectives for some general objective that covers a broad content base, but this practice leads to the development of a test which is unbalanced.

This method recognizes that teachers and evaluators have different reasons for writing objectives. (It is assumed here that the teacher and evaluator are two different people. Of course, it most commonly happens that the teacher changes hats and becomes his own evaluator, but we will make a distinction between these two for purposes of discussion.) A teacher needs to feel that his list of objectives is complete, because it may well be that the worth of a unit is lost if one major component is missing. An evaluator does not need such a complete list, because the measures he uses are always samples anyway. He needs only a representative sample.

HOW TO DEVELOP YOUR OWN UNIT

The first point to be emphasized is that the units are not written as someone's suggestion as to how you should teach your students. The material is organized into units simply because it will be much easier for you to locate the objectives you want to use. Therefore, do not consider this book to be some official guide which requires you to teach certain objectives when teaching the units listed herein.

The second point to be remembered is that you should use the general objectives to plan your teaching. Use the specific objectives only to help clarify what is meant by the general objective. Keep in mind that only a sample of specific objectives is given for each general objective. The philosophy under which these were written precludes the possibility of generating such a set.

To use this catalog in teaching, you might proceed in the following way:

1. Jot down a title for the unit you want to teach. Think about what your students will be doing on the job as an auto mechanic with the material you are going to present in class. If you can write a work-oriented goal statement like the ones in this catalog, go ahead and do so.

2. Turn to the table of contents of this catalog. Note any titles of units which might have objectives related to your proposed unit.

3. Read those units, and then write down the general objectives that you can glean from them that are appropriate for your unit. You may be able to find objectives from several units that you can use in the one you are writing.

4. Review the set of general objectives to make sure they are complete. Remember, the general objectives must be comprehensive. Ask yourself if you have ever had a student who could succeed on all of the objectives you have listed, but failed on the job. If you can figure out why he failed, then you will probably come up with the "missing" objective needed. For example, suppose you are writing a unit on brake maintenance. Perhaps you have had a student who could replace brakes well enough, but often failed to recognize when it was time to replace them. Then you may realize that you need to add one objective that reads something like "The student will recognize worn brake linings and recommend replacement." Of course, now you must help to define what you mean in this general objective by writing a sample of specific objectives which cover it as representatively as possible.

5. When you are satisfied that your general objectives are complete, (usually somewhere between 5 and 10 general objectives) develop your content to cover them.

6. Teach the unit.

7. When ready to develop a test, go back to the specific objectives listed under each general objective you decided to use. Develop a test item which will measure each one. For example, in the unit titled "Diagnosis and Tuneup," the first specific objective under general objective I is:

I.A.--List visible malfunctions by an underhood inspection.

One way to test whether or not the student can actually do this would be with the following test question:

1. In making a visual underhood inspection of an automobile that is misfiring, which of the following malfunctions would NOT be obvious?

    1. Disconnected plug wires
    2. Blow-by from the oil breather cap
    3. A cracked distributor cap
    4. Insulation off primary wires
    5. A broken ground electrode in the spark plug

For your convenience, several test items are included after each unit. Rather than writing your own items, you might prefer to construct your test by selecting from those available.

That should be all there is to doing a whole unit. Of course, there is no need for this unit to be taught to a whole class. If you individualize your instruction, it might be well developed for only one student. But whether you do it for one student or for thirty, the time savings should be substantial, while you still have a unit which is yours alone and written with your students and their needs in mind.

BOOST

BOOST (Behavioral Objectives Organized in a System for Teachers) is a delivery system for objectives, such as those contained in this catalog, and a computer bank of test items associated with the objectives. Rather than having teachers develop their own tests as explained above, the tests are generated for them. In the computer bank, there are several test items written to measure each general objective. A test is developed by selecting items from the pool which are related to any given set of objectives.

A pilot project of BOOST is being conducted with stenographic block teachers of business education in Hampton, Richmond, and Prince William County during the spring of 1974. The extension of BOOST to additional areas in vocational education is dependent upon the availability of funds.

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Unit: INTRODUCTION TO THE AUTOMOBILE

Outline of Unit

I. The Automotive Industry

II. History of the Automobile

III. Basic Operational Theory of Automobile Components

IV. Safety

Goal Statement

The automotive mechanic must acquire basic knowledge and understanding of the automobile in order to become proficient at trouble-shooting, and making component repair or replacement decisions concerning any component of the modern automobile encountered in the service setting. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices.

General and Specific Objectives

I. The student will understand the various units of the automobile. Specifically the student will be able to:

A. given a specific automobile, identify the engine type and design.
B. given a specific automobile, identify the chassis or body construction in relation to engine and wheel support.
C. given a specific automobile, identify the power train.
D. given a specific automobile, identify the body design.
E. given a specific automobile, identify the vehicle body accessories.

II. The student will appreciate the technological developments in the automotive field. Specifically the student will be able to:

A. describe the first gasoline automobile.
B. describe the major changes in the automotive industry.
C. list current job opportunities in the automotive industry.
D. predict possible future opportunities in the automotive service industry.

III. The student will understand the importance and need for each automotive component. Specifically the student will be able to:

A. describe the source of automobile power.
B. describe the construction of support and frame members.
C. describe the process of transmitting power or energy to the drive wheels.
D. describe, in general, automobile body construction.
E. describe, in general, automobile accessories.

IV. The student will understand that certain desirable work habits are necessary for safety. Specifically the student will be able to:

A. describe general automotive safety practices.
B. explain how to use hand tools safely.
C. list some guidelines for personal safety.
D. list auto shop safety precautions that should be followed.

TEST

1. A related group of components assembled in a specific order which converts energy given off by a burning fuel into rotary motion is the

    1. power train.
    2. source of energy.
    3. engine.
    4. internal combustion cylinder.

2. A rigid structural foundation for the car body and solid anchor point for the suspension system is referred to as the

    1. spring.
    2. torsion bar.
    3. rubber-bushed shackle.
    4. frame.

3. The power that the engine develops must be transmitted to the car wheels by way of the

    1. transmission.
    2. propeller shaft.
    3. clutch assembly.
    4. All of the above

4. Unitized body construction means that the

    1. body section has rear rails in addition to a partial frame in front.
    2. body is welded together.
    3. body section has strength members.
    4. frame runs the full length of the body.

5. The accessory used most frequently on today's automobiles is the

    1. windshield wiper.
    2. radio.
    3. defroster.
    4. heater.

6. By 1901 the GREATEST number of automobile factories had been set up in

    1. France.
    2. Germany.
    3. the United States.

7. How many men and women are employed DIRECTLY by the automotive industry?

    1. One out of seven
    2. One out of ten
    3. One out of fifteen
    4. One out of twenty

8. Each year the automotive industry in the U.S. produces MORE than

    1. 10 million automobiles.
    2. 7 million automobiles.
    3. 12 million automobiles.

9. A basic principle of mass production is to

    1. bring the worker to the job.
    2. bring the job to the worker.
    3. produce quality parts for assembly.

10. Which of the following tasks does a general mechanic perform?

    1. Replace piston rings
    2. Repair transmissions
    3. Service electrical systems
    4. All of the above

11. Two of the MOST important ideas the early automobile manufacturers developed were

    1. changeability and production.
    2. internal combustion and mass production.
    3. interchangeable parts and mass production.

12. The modern automobile engine is referred to as an

    1. eight-cycle engine.
    2. internal combustion engine.
    3. external combustion engine.
    4. None of the above

13. Basic components of the automobile which provide comfort and safety for the driver include the

    1. power train and lights.
    2. doors and windows.
    3. power train and steering assembly.
    4. body assembly.

14. The assembly that includes the engine, wheels, power train, brakes, and steering system is referred to as the

    1. car body.
    2. chassis.
    3. automobile.
    4. accessories.

15. The heater, lights, and radio are termed automotive

    1. components.
    2. accessories.
    3. members.
    4. None of the above

16. Slight injuries such as cuts and abrasions should be

    1. ignored.
    2. washed thoroughly.
    3. reported immediately.
    4. treated by a physician.

17. Improperly lifting heavy objects causes one out of every

    1. two disabilities.
    2. four disabilities.
    3. eight disabilities.
    4. sixteen disabilities.

18. Carelessness and horseplay in the shop can result in

    1. the formation of improper work habits.
    2. hurt feelings.
    3. injury.
    4. All of the above

19. After handling caustic acids or batteries it is necessary to

    1. wipe hands with a dry cloth.
    2. wash hands with water.
    3. keep hands away from eyes.
    4. Two and three above

20. To avoid injury, the compressed air blow gun should be

    1. used only with proper eye protection.
    2. pointed toward the floor at all times when in use.
    3. pointed toward others when in use.
    4. used to clean work table surfaces.

21. In addition to gasoline, which of the following represents another serious fire hazard around the automotive shop?

    1. A cable disconnected from the ground battery terminal
    2. Detached and drained carburetors
    3. Piles of oily rags
    4. All of the above

22. Small oil spills on the shop floor should be wiped up

    1. when the job is completed.
    2. immediately.
    3. at the end of the day.
    4. by the building custodian.

23. Four types of springs used in automotive suspension systems are the

    1. leaf, coil, spiral, and bar.
    2. leaf, torsion bar, air, and flat.
    3. leaf, coil, torsion bar, and air.
    4. All of the above

24. Diesel engines are used in some passenger cars to

    1. increase reliability.
    2. reduce fuel costs.
    3. increase high torque outputs.
    4. reduce maintenance.

25. The MAIN function of the clutch is to

    1. shift gears.
    2. provide smooth vehicle starts.
    3. disconnect the engine and the transmission.
    4. allow the engine to idle.

26. The universal joint in the drive shaft is necessary to

    1. provide an easy method to disconnect the drive line.
    2. carry engine torque to the drive wheels.
    3. produce a smooth turning drive line.
    4. allow drive wheel suspension free movement.

27. A typical gear ratio between the engine and the drive wheels with the transmission in low would be

    1. four to one.
    2. eight to one.
    3. twelve to one.
    4. sixteen to one.

28. In the hydraulic braking system, the braking action is produced by friction between the

    1. wheels and the brake drum.
    2. brake drum or disc and the brake shoes.
    3. brake shoes and the wheels.
    4. All of the above

Unit: BASIC HAND TOOLS--FASTENERS AND MEASURING

Outline of Unit

I. Selection and Use of the Mechanic's Basic Hand Tools

II. Selection, Use, and Interpretation of Measuring Instruments

   A. Micrometers
   B. Calipers
   C. Torque Wrenches

III. Selection and Use of the Proper Hand Tools for a Specific Job

IV. Care, Maintenance, and Storage of Hand Tools

Goal Statement

The automotive mechanic selects and uses tools properly and safely. Selection of the proper hand tools will facilitate the accomplishment of all jobs within the allowable time, and promote customer satisfaction with the over-all job performance. The mechanic keeps each tool in a designated place in the tool room or work area. The mechanic must have a thorough knowledge of measuring instruments so that he will be able to perform precision work when it is required.

General and Specific Objectives

I. The student will understand how to select a mechanic's hand tool. Specifically the student will be able to:

   A. given a certain job being done, explain why the automotive mechanic should have the proper tools.
   B. state why punches and chisels vary in size and construction.
   C. describe the important features found in quality tools.
   D. explain why there are different types of files.
   E. list four different socket drives.
   F. state the different sizes of open-end and box-end wrenches.
   G. explain the use of set screw tools.
   H. given a specific type of screw, select the proper screwdriver.
   I. list the hand tools needed to remove and replace the cylinder head of a six cylinder engine.
   J. list tools needed to replace brake linings.

II. The student will understand how to select, use, and interpret measuring instruments. Specifically the student will be able to:

   A. select the instrument used to check movement of end play and run out.
   B. state how to read the dial indicator.
   C. describe the instrument used to measure the space between two surfaces.
   D. explain how to use the inside micrometer.

E. given the decimal reading of a micrometer, convert it to a fractional reading.
F. state the purpose of the torque wrench.

III. The student will know how to make decisions concerning the use of the proper hand tools for a specific job. Specifically the student will be able to:

A. describe the proper way to use a hacksaw.
B. given soft metal, state which file to use.
C. explain how to remove the burrs in a metal hole or cylinder.
D. describe the proper way to use a chisel.
E. explain what the swivel socket is designed to do.
F. describe the use of tubing tools.

IV. The student will know how to select the proper fastener for a specific job. Specifically the student will be able to:

A. list the different sizes of screws.
B. given various bolts, explain their differences as to construction and use.
C. list the different lengths and sizes of cotter pins.

V. The student will recognize acceptable industry standards in the care, maintenance and storage of hand tools. Specifically the student will be able to:

A. state the maintenance procedure for hand tools.
B. state the maintenance procedure for power tools.
C. state why ratchets should be kept clean and lubricated.
D. state the maintenance procedure for a pedestal grinder.
E. state why tools should be stored in their proper place.

VI. The student will demonstrate safe work habits in the use of hand tools. Specifically the student will be able to:

A. state why it is best to pull on a wrench.
B. list several improper uses of a screwdriver.
C. state why tools should be free of grease when using.
D. given a list of safety rules, pick out ones pertaining to hand tools.
E. state why pliers should not be used on nuts.
F. explain why files should have handles.
G. state why screwdrivers should never be used to check high voltage.
H. list the safety precaution to use with a pedestal grinder.

TEST

1. The size of open-end wrenches increases in

    1. 1/16 inch steps.
    2. 1/32 inch steps.
    3. 1/8 inch steps.
    4. 1/4 inch steps.

2. The MAIN reason for using a box type wrench is that it

    1. has greater strength.
    2. works better on rounded nuts.
    3. is less likely to slip on nuts.
    4. increases leverage.

3. The channel-lock pliers are designed to

    1. lock channels.
    2. have adjustable openings and at the same time have the jaws remain parallel.
    3. allow for working in very tight places.
    4. remove radiator hose clamps.

4. The end of a Phillips screwdriver has a

    1. flat blade.
    2. pointed end with four grooves.
    3. fluted end.
    4. square end.

5. An Allen set screw wrench has

    1. four sides.
    2. six sides.
    3. eight sides.
    4. twelve sides.

6. The rounded end of a machinists hammer is known as the

    1. face.
    2. peen.
    3. riveter.
    4. base.

7. A cape chisel is used to cut

   1. narrow grooves.
   2. rivet heads.
   3. tool steel.
   4. None of the above

8. When using a chisel, it should be held

   1. tightly in the hand.
   2. with a pair of slip-joint pliers.
   3. loosely in the hand.
   4. between the thumb and index finger.

9. A screw extractor has

   1. tapered right-hand threads.
   2. tapered left-hand threads.
   3. tapered smooth threads.
   4. tapered coarse threads.

10. A file with a single row of parallel teeth is called a

    1. bastard file.
    2. singleton file.
    3. single-cut file.
    4. cross-cut file.

11. A file with one row of teeth crossing the other is called a

    1. criss-cross file.
    2. double-cut file.
    3. vixen-cut file.
    4. diagonal-cut file.

12. Which type of file should be used first in filing soft steel?

    1. A bastard file
    2. A smooth-cut file
    3. A second-cut file
    4. A mill-cut file

13. What kind of saw blade is recommended to cut soft steel, cast iron and stock of heavy cross section?

    1. 14 tooth
    2. 16 tooth
    3. 24 tooth
    4. 32 tooth

14. After cutting a piece of tubing, it should be reamed

    1. to increase its size.
    2. to restore it to its original size.
    3. to remove any burrs from the cut edge.
    4. All of the above

15. The largest diameter on a bolt is known as the

    1. pitch diameter.
    2. major diameter.
    3. minor diameter.
    4. None of the above

16. Most automotive bolts have a

    1. square head.
    2. octagonal head.
    3. hexagonal head.
    4. round head.

17. When the thimble of a micrometer is turned one mark, as indicated by the lines on the beveled edge of the thimble, how far has the spindle moved?

    1. .001 inch
    2. .0025 inch
    3. .005 inch
    4. .025 inch

18. A dial indicator gauge is frequently used in automotive service work to check

    1. rod bearings.
    2. crankshaft end play.
    3. piston rings.
    4. valve faces.

19. A feeler gauge is used to measure

    1. the thickness of sheet metal.
    2. the diameter of the car engine's cylinders.
    3. the space between two surfaces.
    4. valve guide wear.

20. An SAE die will cut

    1. coarse threads.
    2. deep threads.
    3. fine threads.
    4. shallow threads.

21. Before metal work can be drilled PROPERLY, it should be indented with a

    1. starting punch.
    2. pin punch.
    3. tapered punch.
    4. center punch.

22. Which of the following is the BEST reason to buy more expensive tools when less expensive ones are available?

    1. Strength and long wear
    2. Closer tolerance
    3. Repair parts available
    4. Higher quality finish
    5. All of the above

23. Files come in many different shapes, which of the following is NOT a file shape?

    1. Knife
    2. Round
    3. Flat
    4. Triangle
    5. Concave

24. Holding a chisel at the proper cutting angle is important; it should be held

    1. at a 90 degree angle to the work.
    2. so the lower face of the cutting edge is parallel to the work surface.
    3. straight up.
    4. as close to the work surface as possible.

25. The four MOST popular socket drive sets are

    1. 1/4", 7/16", 1/2" and 3/4".
    2. 1/4", 3/8", 7/8" and 3/4".
    3. 1/4", 3/8", 7/8" and 15/16".
    4. 1/4", 3/8", 1/2" and 3/4".

26. The tool that is designed to measure movement in thousandths of an inch is a

    1. micrometer.
    2. dial indicator.
    3. depth gauge.
    4. caliper.

27. To check the run-out in a flywheel, it is necessary to use a

1. feeler gauge.
2. depth gauge.
3. speed indicator.
4. dial indicator.

28. A feeler gauge is used to adjust the

1. clutch.
2. headlights.
3. valves.
4. toe-in.

29. An extension handle can be used with a(n)

1. inside micrometer.
2. outside micrometer.
3. caliper.
4. feeler gauge.
5. All of the above

30. The decimal reading on a micrometer is 3.125 inches. The fractional equivalent is

1. 3 1/4 inches.
2. 3 7/8 inches.
3. 3 1/8 inches.
4. 3 1/2 inches.
5. 3 12/16 inches.

31. Which of the following tools would NOT be used to remove a cylinder head?

1. Socket
2. Extension
3. Swivel socket
4. Ring compressor
5. Ratchet

32. When cutting with a hacksaw, on the backstroke it would be

1. lifted slightly.
2. pushed downward firmly.
3. pushed downward lightly.
4. lifted one inch from the work.

33. When filing soft material, it is necessary to use a

    1. fine-cut file.
    2. coarse-cut file.
    3. extra fine-cut file.
    4. None of the above

34. The swivel socket allows the mechanic to turn fasteners

    1. tighter.
    2. at an angle.
    3. with a combination wrench.
    4. with a swivel spinner.

35. Nuts are tightened to factory specification by using a(n)

    1. open end wrench.
    2. box end wrench.
    3. combination wrench.
    4. torque wrench.
    5. adjustable wrench.

36. Which of the following tools must be equipped with a handle to guard against serious injury?

    1. Chisels
    2. Files
    3. Wrenches
    4. Punches
    5. Extensions

37. Which of the following is GOOD maintenance procedure for hand tools?

    1. Keep them clean
    2. Store them in their proper place
    3. Lubricate them where necessary
    4. All of the above

38. Which of the following is NOT a required maintenance procedure for power hand tools?

    1. Check for defective power cords
    2. Lubricate where necessary
    3. Repair or replace broken parts
    4. Clean once a day in solvent

39. To INCREASE the life of a ratchet and to keep it operating properly, it would

    1. be kept clean and lubricated.
    2. cleaned with soap and water.
    3. cleaned in kerosene after each use.
    4. cleaned in gasoline after each use.

40. To avoid injury to the hand when loosening a tight nut, it is BEST to

    1. push on the wrench.
    2. use both hands.
    3. pull on the wrench.
    4. always use a pipe extension.

41. To insure the long life of a screwdriver, it should NEVER

    1. be used in place of a pry bar.
    2. be used in place of a chisel.
    3. be hammered on the handle.
    4. be turned with a pair of pliers.
    5. All of the above

42. Tools should be free of grease because of

    1. safety considerations.
    2. difficulty in grip.
    3. difficulty in obtaining leverage.
    4. None of the above

43. The most important reason why pliers should NOT be used to remove a nut is that

    1. they will damage the threads.
    2. they reduce leverage.
    3. they will round off the corners.
    4. None of the above

44. Screwdrivers should NEVER be used to check high

    1. amperage.
    2. resistance.
    3. ohms.
    4. wattage.

45. Which of the following is NOT classified as a brake tool?

    1. Adjusting spoon
    2. Cylinder hone
    3. Spring pliers
    4. Inside-outside caliper
    5. Clutch head screwdriver

46. To remove burrs from a metal hole or cylinder, it is necessary to use a

    1. flat file.
    2. mill file.
    3. round file.
    4. triangular file.
    5. concave file.

47. Which of the following is considered PROPER maintenance for the pedestal grinder?

    1. Keep tool rest adjusted
    2. Keep stone true
    3. Keep lights operating
    4. Keep eye shields in place
    5. All of the above

48. When using the pedestal grinder, it is necessary to

    1. wear goggles.
    2. keep the tool rest adjusted.
    3. hold small objects with pliers.
    4. stand to one side of stone as much as is feasible.
    5. All of the above

49. Fasteners less than 1/4 inch in diameter are classified as

    1. screws.
    2. bolts.
    3. holders.
    4. clamps.

50. When a fastener has threads on both ends, it is referred to as a

    1. bolt.
    2. machine bolt.
    3. stud bolt.
    4. U-bolt.

51. Tools should always be stored in their proper place for

    1. safety reasons.
    2. protecting the tool.
    3. convenience for the mechanic.
    4. quicker inventory.
    5. All of the above

52. To avoid damage to a micrometer, it should NEVER

    1. be used in place of a hammer.
    2. be dropped.
    3. be overtightened.
    4. be left out of its case when not in use.
    5. All of the above

53. When selecting a standard screwdriver,

    1. the tip should have tapered sides.
    2. it should fit the screw slot snugly.
    3. the tip should be 1/8" wider than the screw slot.
    4. the handle should be longer than the shank.

54. To prevent the cutting edges from becoming dull, a reamer should

    1. be turned at a high speed.
    2. be turned as slowly as possible.
    3. never be turned backward.
    4. None of the above

55. Cotter pins are used in

    1. slotted nuts.
    2. castle nuts.
    3. clevis pins.
    4. linkage ends.
    5. All of the above

56. When an extension is used to lengthen a torque wrench,

    1. it will increase the torque.
    2. it will not affect the torque.
    3. it will triple the torque.
    4. it will reduce the torque.

In items 57-67, you will be given special instructions by your instructor. You will be evaluated on the use of measuring devices. (This is only a suggested list. It may vary to suit the instructor.)

57. Measure a crankshaft journal and give the micrometer reading.

58. Measure a cylinder bore and give the inside micrometer reading.

59. Using a ruler and the job sheet provided, measure several parts and give the reading on the job sheet.

60. Measure the threads on several bolts with a screw pitch gauge and give the readings.

61. Using a depth gauge, measure the piston stroke and give the reading.

62. Using a dial indicator, take a movement reading and give the results.

63. Using a foot-pound torque wrench, torque several bolts to a given reading.

64. Given a foot-pound torque wrench, add a six-inch extension to the handle and torque a bolt by a computed reading.

65. Using a telescoping gauge, take a reading and transfer it to an outside micrometer.

66. Using a spark plug gauge, gap several spark plugs to a specified setting.

67. Using a feeler gauge set, take several specified readings.

Unit: GENERAL SERVICE PROCEDURE

Outline of Unit

I. Importance of Basic Service Procedures

II. Operation of Automotive Components

III. Construction of Automotive Components

IV. Use of Test Equipment

V. Terminology

VI. Safety

VII. Basic Service Decisions

VIII. Repair or Replacement of Components

Goal Statement

Automobile mechanics are aware of the nomenclature, construction and operation of the components involved in servicing the modern automobile. They must have entry level skill in the use of test equipment and in proper service procedures. They must be able to repair or replace defective components in a safe manner. To be a proficient technician, they must be able to communicate with customers, fellow workers, and employers and be able to understand service manuals.

General and Specific Objectives

I. The student will understand the need for having a good service procedure. Specifically the student will be able to:

   A. systematically list the steps involved in the proper service of an automobile.
   B. explain the need for different lubrications.
   C. explain the importance of a clean filter.
   D. list precautions which will prolong the operation of a vehicle.
   E. identify areas where excessive wear has occurred.

II. The student will understand the operation of all systems' components. Specifically the student will be able to:

   A. describe the storage battery's operation.
   B. explain the operation of the radiator pressure cap.
   C. explain the need for a pressurized cooling system.
   D. state the function of the exhaust system.
   E. explain the need for grease seals.

III. The student will understand automotive component design characteristics. Specifically the student will be able to:

   A. list the parts of the storage battery.
   B. describe the construction of a cooling system.
   C. given different tires, state their construction.
   D. given different types of waterpumps, distinguish between them.
   E. state the need for a good lubricating system.

IV. The student will understand the importance of proper use of test equipment. Specifically the student will be able to:

   A. demonstrate the correct operation of the hydrometer.
   B. list the step-by-step procedure for hooking up a meter.
   C. use an anti-freeze tester properly.
   D. explain why a pressurized cooling system is necessary.
   E. list the steps of a battery three-minute test.

V. The student will understand the correct terminology in reference to all aspects of general service. Specifically the student will be able to:

   A. identify service parts and materials, using their correct names.
   B. communicate effectively with other service personnel.
   C. use service manuals and charts to determine the proper procedure.
   D. use the manufacturer's terminology in describing the trouble-shooting procedure.

VI. The student will recognize the danger related to certain aspects of automobile repair. Specifically the student will be able to:

   A. explain the dangers involved in using a heating torch to remove the parts of the exhaust system.
   B. identify shop safety procedures.
   C. identify the dangers involved in charging a battery.
   D. cite the danger of an exhaust system that is leaking.
   E. use the proper procedure with the car lift.

VII. The student will understand how to make service decisions. Specifically the student will be able to:

   A. given a specific situation, select the proper tester.
   B. determine if a part can be overhauled or if it must be replaced.
   C. given a specific situation, select the best lubrication.
   D. given a particular malfunction, determine the best way to repair it.

VIII. The student will understand how to store components of a vehicle to the manufacturer's specifications by service, repair or replacement. Specifically the student will be able to:

   A. state the steps in the repair of a radiator.
   B. identify the proper procedure for lubricating an automobile.

C. choose a step-by-step procedure for charging a direct current storage battery.
D. list, in order, the steps for using a tire changer.
E. select the proper procedure for removing and replacing an oil filter.
F. explain how to replace a wheel bearing.
G. list, in order, the steps for using a wheel balancer.

TEST

1. Which step below is NOT necessary in replacing a defective thermostat?

   1. Drain the oil from the engine
   2. Drain the coolant from the radiator
   3. Remove the hoses from the thermostat housing
   4. Remove the thermostat housing
   5. Remove the thermostat gasket

2. A manual steering unit is filled with which of the following lubricants?

   1. Power steering fluid
   2. Dextron, type A
   3. 60 weight engine oil
   4. Calcium soap no. 2

3. Which of the following descriptions does NOT refer to an oil filter system?

   1. By-pass type
   2. Splash type
   3. Full-flow type
   4. Full-flow with blow-off valve

4. Air filters have several purposes. Which of the following purposes is NOT one of them?

   1. To help control backfire flame
   2. To protect the engine by removing solids from the air entering the engine
   3. To regulate the flow of air to the carburetor
   4. To filter the air into the crankcase

5. When the engine oil pump has been disassembled to assure rapid priming, it would be filled with which of the following?

   1. Chassis lubrication
   2. Engine oil
   3. Petroleum jelly
   4. None of the above

6. Which of the following is NOT true concerning a defective thermostat? It causes the

    1. engine to run too cool.
    2. engine to run too hot.
    3. engine not to run at all.
    4. engine to use too much gas.

7. Which of the following is NOT true concerning engine lubrication?

    1. It provides a liquid film on which metal parts can ride.
    2. It seals the gap between the parts.
    3. It carries the heat of friction to the crankcase.
    4. It creates heat for a faster combustion.

8. A battery produces electricity as a result of

    1. current flow.
    2. chemical change.
    3. resistance change.
    4. induction.

9. Water in a sealed container under ten pounds of pressure will not boil until it reaches

    1. 212 degrees
    2. 222 degrees
    3. 232 degrees
    4. 242 degrees

10. Radiator caps have several purposes. Which of the following is NOT one of them?

    1. To keep the radiator from leaking (due to pressure control)
    2. To control the pressure to a predetermined level
    3. To control the vacuum within the system
    4. To allow the water to get hotter than 212° without boiling

11. Heat may be transferred from one medium to another by

    1. radiation.
    2. convection.
    3. conduction.
    4. All of the above
    5. None of the above

12. The temperature of the burning fuel in an automobile engine is approximately

    1. 850 degrees
    2. 1000 degrees
    3. 4500 degrees
    4. The temperature cannot be determined.

13. Heat always flows from a

    1. cold to a hot object.
    2. high to a low region.
    3. hot to a cold object.
    4. metal to a liquid.

14. The manifold heat valve is controlled by

    1. a thermostatic coil spring.
    2. the counterweight.
    3. the velocity of the exhaust gases.
    4. All of the above
    5. None of the above

15. A twelve volt battery is made up of

    1. six 2-volt cells in series.
    2. three 2-volt cells in series.
    3. three 2-volt cells in parallel.
    4. six 2-volt cells in parallel.

16. What is the MAIN purpose of the water pump by-pass hose?

    1. To relieve excessive pressure on the engine during high speed driving.
    2. To insure the circulation of coolant when the thermostat is closed.
    3. To prevent an air pocket in the water pump housing.
    4. To prevent the collapse of the lower hose due to the water pump creating a vacuum.

17. The heat exchanger often found in the bottom of a radiator is used to cool the

    1. power steering fluid.
    2. disc brake fluid.
    3. automatic transmission fluid.
    4. refrigerant in the air conditioner.

18. Which statement is NOT true concerning tires?

    1. Two-ply/four-ply rating indicates four layers of two-ply twisted cord.
    2. "Belted bias" means cord put on the tire diagonally to the body of the tire.
    3. Steel belted tires are stronger than rayon belted tires.
    4. Tubeless tires can be two- or four-ply rated.

19. Conventional water pumps are examples of which of the following designs?

    1. Plunger
    2. Gear
    3. Impeller
    4. Vane

20. Temperature must be considered when using a battery hydrometer. Which of the following scales indicates a PROPER conversion allowance?

    1. .8 for 10 degrees
    2. .10 for 100 degrees
    3. .4 for 10 degrees
    4. .1 for 1 degree

21. Voltmeters are usually connected when testing a circuit in which of the following ways?

    1. Parallel
    2. Series-parallel
    3. Series
    4. None of the above

22. Ammeters are usually connected when testing a circuit in which of the following ways?

    1. Parallel
    2. Series-parallel
    3. Series
    4. All of the above
    5. None of the above

23. Anti-freeze testers have more than one scale. Which statement BEST describes why this is necessary?

    1. To allow for the temperature of fluid tested
    2. To read different mixtures of anti-freeze
    3. To use the tester as a hydrometer for testing batteries
    4. To allow for the air temperature at the time of testing

24. Which statement LEAST describes why a cooling system is pressure-tested?

    1. To see if the pressure cap will hold the designated pounds of pressure
    2. To see if the system will hold the designated pounds of pressure
    3. To see if the system is clogged with rust
    4. To see if the head gasket is leaking water

25. In reference to engine oil, viscosity is

    1. the measure of resistance of oil to motion or flow.
    2. the cohesion of oil.
    3. the ability of oil to clean.
    4. All of the above

26. There are many acceptable ways to answer a business phone; however, which of the following is NOT considered acceptable?

    1. "N.A.P.A. Jones' Auto Repair"
    2. "Jim's Auto Service, Jim speaking"
    3. "Hello, John speaking"
    4. "James' Auto Service, may we help you?"

27. Given a service manual or a table of specifications, which statement is INCORRECT for a 1971 Chevrolet with an automatic transmission and a 245 horsepower, 350 cubic inch engine?

    1. Basic timing is six degrees.
    2. Dwell is 31 degrees.
    3. Spark plug gap is .035 inch.
    4. Curb RPM is 475 drive.

28. Voltage means

    1. electrical pressure.
    2. electrical resistance.
    3. current flow.
    4. electrical quality.

29. The term amperage refers to

    1. electrical pressure.
    2. electrical resistance.
    3. current flow.
    4. None of the above

30. Electrical resistance is measured in

    1. volts.
    2. E.M.F.
    3. amperes.
    4. ohms.

31. Which of the following statements is NOT true?

    1. Static balance is balance at rest.
    2. Static balance is balance in motion.
    3. Static unbalance will cause the wheel to hop.
    4. Static unbalance can be corrected.

32. Which of the following statements is TRUE?

    1. You can use acetylene goggles for electrical welding.
    2. It is safe to watch acetylene welding without goggles but not electrical welding.
    3. A broken valve will "rocket" a full oxygen cylinder.
    4. The pressure should be left on welding gauges when they are not in use.

33. Which of the following statements is NOT correct?

    1. For safety's sake, remove the battery ground cable first.
    2. A battery gassing while charging can explode.
    3. Electrolyte will damage many materials.
    4. The best substance for removing spilled electrolyte is soap and water.

34. Which of the following statements is NOT correct?

    1. State law requires safety glasses in the shop area.
    2. Soda-acid fire extinguishers are best for gas fires.
    3. Safety stands must be used under raised vehicles.
    4. Floor jacks will sometimes "leak" down.

35. Which statement is NOT correct in reference to a leaking exhaust system?

    1. The muffler is a filter; therefore, a leak behind the muffler is dangerous.
    2. Breathing exhaust fumes will damage the brain.
    3. Sometimes one may not smell exhaust until it is too late.
    4. A vehicle must not have any holes in the floor pan since exhaust fumes could get through.

36. Which procedure is CORRECT when using a twin post lift?

    1. Drive the car on the lift straight. Set the hand brakes, put in park gear. Adjust rear post to frame. Raise car, both ends equally.
    2. Drive the car on the lift straight. Set the hand brakes. Adjust the rear post to the wheels. Raise the rear ahead of the front end.
    3. Drive the car on lift straight. Do not set the hand brakes or put in park gear. Adjust the rear post to axle. Raise the vehicle.
    4. Drive the car on the lift straight. Do not set the hand or park brakes. Adjust the post to axle. Raise the front ahead of the rear.

37. Engine operating temperature is usually increased as

    1. spark is retarded.
    2. RPM is increased.
    3. spark is advanced.
    4. load is reduced.

38. When lubricating a ball joint, which of the following is TRUE?

    1. All the old lubrication should be pushed out.
    2. A grease with a soap base should be used.
    3. Wheel bearing grease should be used.
    4. The weight should be off the ball joint.

39. A connecting rod bearing with too much clearance may

    1. reduce engine temperature.
    2. throw excessive oil on the cylinder walls.
    3. cause excessive vibrations.
    4. knock, but cause no other trouble.

40. A good engine oil should have

    1. body and fluidity.
    2. resistance to oxidation.
    3. resistance to carbon formation.
    4. resistance to foaming.
    5. All of the above

41. The most COMMON symptom of universal joint failure is a

    1. heavy rumble during acceleration.
    2. whine during acceleration.
    3. heavy rumble during turning.
    4. whine during turning.

42. Which statement below is INCORRECT with reference to repairing a radiator?

    1. Clean the radiator before testing
    2. Use a pressure test to check for leaks
    3. Use rosin core solder to repair the leak
    4. Retest and paint radiator

43. Which step below is NOT a proper procedure to use when lubricating an automobile?

    1. Lubricate a fitting until the grease is forced out of the dust boot
    2. Lift the weight of the ball joint to grease it
    3. Fill the differential until finger will reach grease
    4. Replace any clogged fittings

44. Which sequence is PROPER for setting up a battery charger?

    1. Do not remove the cables or the alternator wire. Remove caps, fill with water. Hook the leads and charge battery. Unhook charger and replace caps.
    2. Remove the cables. Do not remove the alternator wire. Remove caps. Hook leads and charge battery. Fill with water.
    3. Remove the cables. Remove the caps, fill with water. Take hydrometer reading. Connect leads and charge battery. Remove leads and install caps.
    4. Hook up charging leads. Remove caps, fill with water. Take hydrometer reading. Install acid as needed. Remove leads and install caps.

45. Which is NOT a proper step in the operation of the tire changer to change a 14 inch tire?

    1. Remove the valve stem core to release the air
    2. Install the wheel on the tire changer with the outside of the wheel up
    3. Break the tire from the wheel rim
    4. Remove the tire from the rim
    5. Install the tire and inflate to the proper pressure

46. The BEST way to remove a bearing from a hub is to

    1. use a line punch and drive out the bearing.
    2. use a pry bar to pry the bearing out of the hub.
    3. use a cold chisel to cut the bearing.
    4. install a spindel nut on the spindel, hook the bearing over the nut and jerk it out.

47. Which is NOT a proper step in changing a "spin on" oil filter?

    1. Drain the engine oil
    2. Use a special tool to remove oil filter
    3. Lubricate the new oil filter gasket
    4. Install and tighten the filter with a wrench

48. Which of the following statements is NOT true?

    1. Dynamic balance is balance in motion.
    2. Dynamic balance is balance at rest.
    3. Dynamic unbalance can be corrected.
    4. Dynamic unbalance will cause wheel shimmy.

Unit: ENGINE THEORY AND SERVICE

Outline of Unit

I. Introduction to Internal Combustion Engines

II. Types of Internal Combustion Engines

III. Four Stroke Cycle Engine

  A. Construction techniques
  B. Operating theory
  C. Disassembly and reassembly
  D. Service, maintenance and repair

IV. Summary and Application

Goal Statement

The automotive mechanic successfully trouble shoots, makes component repair or replacement decisions concerning the engine as encountered in the service setting and follows this with corrective action. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manuals. He also must be able to communicate effectively with other service personnel.

General and Specific Objectives

I. The student will know the mechanical and scientific principles involved in the automobile engine. Specifically the student will be able to:

  A. state the physical principles involved in engine operation of a four-stroke cycle.
  B. name, identify, and give the purpose of the basic parts of an engine.
  C. given different cylinder arrangements, identify the engine cylinder block.
  D. describe the action taking place within a cylinder during the four strokes of a four-stroke cycle engine.
  E. name the basic types of valve arrangements.
  F. name the types of piston rings.
  G. describe the chemical reaction of combustion.
  H. describe the types of internal combustion engines, including the Wankel engine.
  I. describe the path of exhaust gas flow.
  J. describe the distribution of fuel-air to the cylinders.
  K. state the procedure for checking engine performance against specifications.

II. The student will select, use and care for the basic and special engine tools and equipment. Specifically the student will be able to:

A. given an engine and several torque wrenches, select and use a torque wrench for tightening the crankshaft main cap bolts.
B. given an engine, inside and outside micrometers, compute crankshaft oil clearance.
C. given an engine, gauging plastic, and connecting rod bearings, interpret connecting rod oil clearance.
D. list the precautions to be observed while using a micrometer.
E. given an engine and a ridge remover, perform the operation necessary to remove a ridge from a cylinder.
F. given a piston and a ring groove cleaner, prepare a piston for ring installation.

III. The student will develop sufficient manipulative and communicative skills and related technical knowledge of engine diagnosis and service. Specifically the student will be able to:

A. given an engine torque wrench and specification tables, torque the head bolts in proper sequence according to specifications.
B. given a crankshaft and a micrometer, interpret micrometer readings to determine proper service procedures according to specifications.
C. list parts normally replaced during a general engine overhaul.
D. list the six requirements of engine bearings.
E. given an engine and feeler gauge, interpret readings during piston ring installation in accordance to specifications.
F. given an engine and bearings, describe the procedure for proper bearing installation.
G. describe the procedures for proper valve train service.

IV. The student will develop safe work habits. Specifically the student will be able to:

A. given several methods, select the proper one for lifting engine blocks.
B. differentiate between a safe and a hazardously mounted engine on a stand.
C. list the hazards pertaining to the use of compressed air.
D. name the hazard involved in the use of gasoline as a cleaning agent.

V. The student will develop good work habits of orderliness, cleanliness, and caring for property. Specifically the student will be able to:

A. describe the possible outcome of reassembling an engine without properly cleaning all component parts.
B. use the parts breakdown and parts list to itemize parts during engine overhaul to impress the user with replacement costs because of damage.
C. use a flat rate manual to list the times involved in engine rebuilding to impress upon the user the importance of conserving of time.

TEST

1. Engine parts that convert reciprocating motion to rotary motion are the

    1. crankshaft and fly wheel.
    2. piston rod assembly and crankshaft.
    3. cylinder and piston rod assembly.
    4. connecting rod and piston.
    5. fly wheel and piston rod assembly.

2. The I-head or overhead valve arrangement is most widely used because it makes possible engine designs with

    1. higher compression ratios.
    2. higher clearance volume.
    3. higher intake ratio.
    4. higher compression volume.
    5. higher intake volume.

3. The two types of piston rings are

    1. compression and locking.
    2. compression and power.
    3. compression and oil control.
    4. compression and expansion.

4. As the temperature increases within the cylinder, pressure

    1. increases.
    2. decreases.
    3. remains the same.
    4. None of the above

5. Events take place in the cylinder in which of the following sequences?

    1. Exhaust, compression, power, intake
    2. Intake, power, compression, exhaust
    3. Compression, power, intake, exhaust
    4. Intake, compression, power, exhaust
    5. Power, exhaust, compression, intake

6. Combustion is a chemical reaction during which atoms of oxygen from the air unite with atoms of

    1. water.
    2. hydrogen.
    3. carbon.
    4. water and hydrogen.
    5. hydrogen and carbon.

7. Main engine bearings are prevented from turning in their housing bore by the bearing

    1. tang.
    2. spread.
    3. cap torque.
    4. crush.

8. In the Wankel engine the rotor has

    1. two lobes.
    2. three lobes.
    3. four lobes.
    4. five lobes.
    5. six lobes.

9. The two main sections of the gas turbine engine are the power section and the

    1. turbine section.
    2. transmission gear section.
    3. gasifier section.
    4. lubrication section.
    5. injector section.

10. Which of the following is CORRECT?

    1. Carbon monoxide is a deadly gas.
    2. Carbon monoxide is used to inflate the tires on race cars.
    3. Carbon monoxide will explode.
    4. Carbon monoxide is used in welding.
    5. Carbon monoxide is harmless to humans.

11. What is the ADVANTAGE of the hydraulic valve lifter over the mechanical valve lifter?

    1. It has quieter valve action.
    2. It closes the valve faster.
    3. It has more accurate valve timing.
    4. It opens the valve faster.

12. The engine with one valve in the head and one valve in the block is known as the

    1. T type.
    2. L type.
    3. F type.
    4. I type.
    5. Y type.

13. The crankshaft changes reciprocating motion to

    1. parallel motion.
    2. perpendicular motion.
    3. horizontal motion.
    4. forward motion.
    5. rotary motion.

14. Most automobile engine designs are of the

    1. V-8 type.
    2. V-6 type.
    3. 4 in-line type.
    4. 8 in-line type.
    5. V-4 type.

15. Both intake and exhaust valves are CLOSED during the

    1. compression stroke.
    2. exhaust stroke.
    3. intake stroke.
    4. None of the above

16. Most engine main and connecting rod bearings are of the

    1. bushing type.
    2. ball bearing type.
    3. split sleeve type.
    4. roller bearing type.
    5. tapered roller type.

17. The two major means by which the exhaust valve can lose heat are through the

    1. valve stem and lifter.
    2. valve stem and valve guide.
    3. valve guide and valve seat.
    4. valve seat and cylinder head.
    5. valve stem and exhaust manifold.

18. A typical V-8 engine will have

    1. one exhaust manifold.
    2. two exhaust manifolds.
    3. a combination exhaust/intake manifold.
    4. a water-cooled exhaust manifold.
    5. no exhaust manifolds.

19. On typical V-8 engines the manifold extending between the cylinders is the

    1. intake manifold.
    2. coolant manifold.
    3. vacuum manifold.
    4. exhaust manifold.
    5. None of the above

20. To check the connecting rod bearings' fit with a plastigage

    1. do not rotate the crankshaft.
    2. rotate the crankshaft after tightening the cap.
    3. do not tighten the cap to torque specifications.
    4. place plastigage between the bearing and the cap.
    5. place plastigage between the bearing cap and the block.

21. Compute oil bearing clearance from the following micrometer readings: crankshaft outside diameter = 2.488, crankshaft bearing inside diameter = 2.490.

    1. 2.012
    2. 0.014
    3. 0.004
    4. 2.002
    5. 0.002

22. Which one of the following is NOT the recommended practice for using a micrometer?

    1. Using it on flat surfaces
    2. Using it on round pieces
    3. Clamping it tightly to workpiece
    4. Using it on a clean surface to be measured
    5. Keeping the instrument clean

23. If noticeable cylinder ridges are not removed during engine disassembly, this will most likely cause

    1. rod damage.
    2. cylinder damage.
    3. bearing damage.
    4. piston damage.

24. Failure to properly clean piston ring grooves will cause the piston and rings when replaced in their respective cylinders to

    1. lack compression.
    2. seize.
    3. knock.
    4. tilt.
    5. None of the above

25. The requirement of a bearing which allows it to absorb dirty particles and thereby reduce the possibility of scratching the crankshaft is

1. load-carrying capacity.
2. imbedability.
3. oil clearance.
4. bearing spread.
5. conformation.

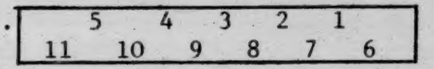
26. Piston ring end gap is determined by using a

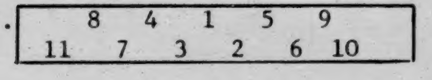
1. feeler gauge.
2. outside micrometer.
3. inside micrometer.
4. caliper.
5. straight edge.

27. In a four-stroke-cycle engine, the camshaft speed is

1. the same as the crankshaft speed.
2. four times the crankshaft speed.
3. twice the crankshaft speed.
4. one-half the crankshaft speed.
5. not related to the crankshaft speed.

28. Which is the CORRECT sequence of tightening the head bolts?

1.


2.


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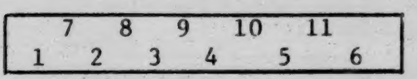
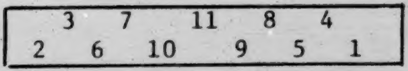


4.


29. A crankshaft measured with a micrometer is found to be uniformly worn .001. The recommended service procedure would be to

1. regrind the crankshaft.
2. install .001 oversized bearings to original crankshaft.
3. install .001 undersized bearings to original crankshaft.
4. replace the crankshaft.

30. The six bearing requirements are: load-carrying capacity, fatigue resistance, corrosion resistance, conformation and

    1. bearing spread and wear rate.
    2. oil clearance and imbedability.
    3. oil clearance and wear rate.
    4. bearing spread and oil clearance.
    5. wear rate and imbedability.

31. After honing a cylinder, clean the wall with

    1. hot water and scouring powder.
    2. a mixture of oil and kerosene.
    3. a rag soaked with gasoline.
    4. warm water and soap.
    5. a rag soaked with a lacquer thinner.

32. The major enemy of service work in engine overhauling which can lead to early failure is

    1. dull tools.
    2. dirt.
    3. steam cleaning.
    4. insufficient tools.
    5. All of the above

33. The force that causes the engine to run is the

    1. exhaust gas leaving the cylinder.
    2. high pressure gases pressing on the piston.
    3. gasoline's chemical energy released when mixed with air.
    4. compression ratio between gasoline and air.

34. A rocker arm is used in the valve train to

    1. compensate for valve train lash.
    2. locate the valves for easy accessibility.
    3. allow for ease of disassembly.
    4. reverse the direction of valve train motion.

35. The power the engine produces is proportional to the

    1. maximum engine speed.
    2. volume of the intake charge.
    3. engine displacement.
    4. compression ratio of the engine.

36. A diesel engine requires

    1. a special igniter.
    2. expensive fuel blends.
    3. timed fuel injection.
    4. large intake and exhaust valves.

37. Overhead valve arrangements are designed to provide the engine with

    1. less oil loss past the valve guide.
    2. a simplified low cost cylinder head.
    3. an ideal camshaft location.
    4. good engine breathing.

38. High compression ratios result in

    1. high combustion pressures.
    2. high speed operation.
    3. smooth power output.
    4. smooth acceleration at medium speeds.

39. Engine horsepower results from the engine's

    1. torque and compression ratio.
    2. speed and displacement.
    3. torque and speed.
    4. compression ratio and displacement.

40. An engine's volumetric efficiency relates directly to

    1. gasoline octane and atmospheric pressure.
    2. engine speed and gasoline octane.
    3. atmospheric pressure and engine load.
    4. air consumption and engine speed.

41. In passenger car engines, the bottom of the intake manifold is usually flat. Which of the following is the BEST reason for this design?

    1. To have the largest cross section possible for the manifold wall area
    2. To improve fuel evaporation in the manifold
    3. To allow space for two runner levels
    4. To conform to block design

42. The exhaust crossover in the intake manifold is MOST helpful to engine operation during

    1. warm-up.
    2. engine starting.
    3. acceleration.
    4. All of the above

43. A shield is used between the engine interior and the base of some intake manifold castings to

1. direct the crankcase gases to the ventilating system.
2. prevent engine oil leakage.
3. control the amount of heat that gets to the manifold.
4. minimize oil cooking and burning.

44. The muffler silences the exhaust by

1. holding the pressure within the exhaust system.
2. removing the noise producing vibrations.
3. gradually releasing the high pressure gas.
4. None of the above

45. Valves are closed by the

1. camshaft.
2. spring.
3. rocker arm.
4. push rod.

46. When checking for the amount of ring end gap, place the ring

1. on the piston.
2. at the top of the cylinder travel.
3. halfway into the cylinder bore.
4. at the bottom of the cylinder travel.

47. Exhaust valves can be made smaller than intake valves because

1. exhaust gas moves at higher speeds.
2. intake gases are cooler.
3. exhaust gas has expanded.
4. intake gases require more area.

48. Sodium filling is used in some exhaust valves to

1. keep the gas from getting so hot.
2. transfer heat from the valve head to the valve guide.
3. lighten the valve for high speed operation.
4. increase valve strength.

49. Oil seals are used on valves to keep the oil from getting into the

1. intake manifold.
2. water jacket.
3. cylinder.
4. cooling system.

50. Compression rings are often coated. The coating that withstands high temperature scuffing the best is

    1. molybdenum.
    2. chromium.
    3. Teflon.
    4. iron oxide.

51. Expanders are used with some piston rings. Their primary purpose is to

    1. make up for cylinder wear.
    2. reduce dynamic tension.
    3. increase static tension.
    4. compensate for ring wear.

52. High pressure combustion gases leak through the top ring gap. This leakage

    1. helps seal the second ring.
    2. is undesirable.
    3. overloads the second ring.
    4. is finally controlled by the oil ring.

53. If the cylinder ridge is not removed when new rings are installed it will most likely cause trouble after reassembly by

    1. allowing blow-by.
    2. breaking the second piston land.
    3. causing pre-ignition.
    4. allowing the piston to hit the valve.

54. Before the valves are pushed out of the valve guide, they should be checked for

    1. burrs at the lock grooves and tip.
    2. burned valve faces.
    3. broken valve springs.
    4. damaged valve locks.

55. Low speed, full throttle operation, or lugging will lead to early engine bearing failure called

    1. embedded failure.
    2. wiping failure.
    3. fatigue failure.
    4. scoring failure.

56. Valve timing and engine breathing are based on

    1. piston position.
    2. crankshaft rotation angle.
    3. connecting rod motion.
    4. combustion rate.

57. The valves are fully open when the piston is

    1. near the bottom center.
    2. near the top center.
    3. moving near maximum velocity.
    4. approaching maximum acceleration.

58. One ADVANTAGE of an overhead camshaft is

    1. the reduction of engine cost.
    2. a quieter running engine.
    3. an increase in engine rigidity.
    4. an engine with less moving parts.

59. Engine power is produced in the combustion chamber by

    1. an explosion of the induction charge.
    2. expanding gases.
    3. high temperature.
    4. the air-fuel ratio and ignition.

60. Approximately how much of the gasoline total heat energy is transferred into useful work?

    1. 25 percent
    2. 50 percent
    3. 75 percent
    4. 100 percent

61. Distance times force equals

    1. power.
    2. work.
    3. inertia.
    4. energy.

62. The rate, or speed, at which work is done is called

    1. power.
    2. force.
    3. inertia.
    4. energy.

63. One horsepower is

    1. 3,300 foot-pounds per second.
    2. 33,000 foot-pounds per second.
    3. 3,300 foot-pounds per minute.
    4. 33,000 foot-pounds per minute.

64. The difference between the amount of air that actually enters the cylinder and the amount that could enter under ideal conditions is called the

    1. compression ratio.
    2. compression efficiency.
    3. volumetric ratio.
    4. volumetric efficiency.

65. On Chevrolet engines with the ball-pivot rocker arm, adjustment of the valve clearance is made by

    1. replacing the push rod.
    2. replacing the rocker arm.
    3. turning the adjusting nut.
    4. turning the adjusting screw.

66. Carbon accumulations in the combustion chamber are the result of

    1. oil.
    2. gasoline.
    3. water.
    4. dirt.

67. A weak valve spring should be

    1. stretched.
    2. heat treated.
    3. reinstalled with spacer.
    4. replaced.

68. If a valve is ground to a point where the margin is eliminated, it will

    1. overheat.
    2. seal better.
    3. run cooler.
    4. close quicker.

69. When a gauging plastic is used to measure bearing clearance, the more the plastic is flattened, the

    1. thinner the bearing shell.
    2. greater the bearing clearance.
    3. less the bearing clearance.
    4. None of the above

70. Valve sticking could be caused by gum or carbon deposits on the stem,

    1. excessive spring pressure or warped stems.
    2. cocked spring or worn camshaft.
    3. warped stem or cracked spring.
    4. All of the above

71. The type valves used on the Wankel engine are

    1. poppet.
    2. sliding.
    3. rotary.
    4. None of the above

72. The Wankel engine and conventional piston engine are alike because both have

    1. a water pump.
    2. connecting rods.
    3. a valve mechanism.
    4. an apex seal.

73. The Wankel engine and the conventional piston engine differ in that one engine does NOT have

    1. a water pump.
    2. an oil pump.
    3. an ignition distributor.
    4. a valve camshaft.

74. The initial ADVANTAGE of the Wankel engine over the other internal combustion engines is that

    1. no spark plug is necessary.
    2. there are fewer moving parts.
    3. the flywheel is eliminated.
    4. it has a high horsepower output.

75. Which of the following is NOT replaced during an engine overhaul?

    1. Piston rings
    2. Main bearing
    3. Connecting rod bearings
    4. Camshaft bearings
    5. None of the above

76. To avoid injury, the compressed air hose should

    1. be used to blow dirt off your clothes.
    2. be pointed toward the ground at all times.
    3. never be used to blow dirt off clothes.
    4. be used to clean off work benches and floors.

Matching - For questions 77-81, match each function in the left-hand column with a part from the right-hand column. Each part should be used only once.

	FUNCTION		PART
___77.	Supports the crankshaft	A.	Crankshaft
___78.	Drives the camshaft	B.	Block
___79.	Operates the valves	C.	Exhaust valve
___80.	Supports the flywheel	D.	Camshaft
___81.	Where the gas burns	E.	Cylinder
		F.	Timing chain
		G.	Flywheel

For questions 82-86, match each part in the left-hand column with the description from the right-hand column. Each description should be used only once.

	PART		DESCRIPTION
___82.	Piston	A.	Has locking lugs
___83.	Wrist pin	B.	Controls oil use
___84.	Camshaft	C.	Has throws
___85.	Main bearing	D.	Case hardened
___86.	Connecting rod	E.	Cam ground
		F.	Controls valve duration
		G.	Should be checked for alignment

Items 87-90 require actual shop work and the use of special tools and equipment. Follow the instructor's directions to comply with the following:

87. Select the proper torque wrench and after checking specifications, properly torque crankshaft main bolts.

88. Properly lift engine and safely mount it to an engine work stand.

89. Using a parts' price list, itemize an engine's overhaul list of parts and their costs.

90. Using a flat rate manual, list the times involved in rebuilding an engine.

Unit: THE FUEL SYSTEM

Outline of Unit

I. Introduction
II. Fuel Tank
III. Fuel Lines
IV. Fuel Pump
V. Fuel Filters
VI. Carburetors
VII. Air Cleaners
VIII. Manifolds
IX. Diagnosis, Adjustments and Repairs

Goal Statement

The automotive mechanic successfully trouble shoots, makes component repair or replacement decisions concerning the fuel system as encountered in the service setting and follows this with corrective action. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manuals. He also must be able to communicate effectively with other service personnel.

General and Specific Objectives

I. The student will understand the theory, design features, and terms related to the fuel system. Specifically the student will be able to:

   A. given a drawing of the fuel system, identify each part.
   B. given a drawing of the fuel system, trace the flow of fuel from the tank to combustion chamber.
   C. given a component part from the fuel system, identify and explain the operation of each item.
   D. list the basic principles used in the design of each component of the fuel system.

II. The student will understand the importance of safe working practices while performing tests and repairs on the fuel system. Specifically the student will be able to:

A. list the types of apparel that should be worn in the shop.
B. list the emergency equipment that should be nearby while testing or repairing the fuel system.
C. list the safety precautions to observe while testing and repairing the fuel system.

III. The student will recognize the problems related to each component in the fuel system. Specifically the student will be able to:

A. identify fuel system problems using the proper tools and test equipment.
B. operate test equipment safely and in the proper sequence.
C. explain the need for a vented fuel tank.
D. explain the operation of the fuel evaporation control system and the possible service problems.
E. list possible malfunctions in the carburetor, fuel pump and fuel tank.

IV. The student will understand the importance of knowing how to interpret all tests normally performed on the fuel system. Specifically the student will be able to:

A. given a vacuum-pressure gauge and operational engine, determine the fuel pump vacuum and pressure.
B. given a fuel-air ratio meter, tachometer, and operational engine, determine the fuel-air ratio at the correct idle speed.
C. given a tachometer and operational engine, correctly set the idle speed while attaining reasonably smooth engine operation.

V. The student will understand the importance of acquiring knowledge and skill to perform assigned jobs at a rate of time meeting entrance level industry standards. Specifically the student will be able to:

A. given a specific car, remove, clean and replace the fuel tank.
B. given a specific car and a replacement fuel pump, replace the fuel pump.
C. given a carburetor and an overhaul kit, disassemble, clean and install kit components.
D. given a dirty paper air filter element, clean it in a safe and correct manner.
E. given a dirty polyurethane air filter element, clean it in a safe and correct manner.

TEST

1. Fuel-air mixtures are measured in

    1. cubic feet.
    2. pounds.
    3. square feet.
    4. cubic tons.

2. A carburetor, in its simplest form, may be referred to as a(n)

    1. proportioner.
    2. mixing valve.
    3. mixer.
    4. atomizer.

3. The octane rating of gasoline refers to its

    1. volatility.
    2. anti-knock properties.
    3. heat release.
    4. evaporation point.

4. When one gallon of gasoline is burned in an engine, how many gallons of water are produced?

    1. 1/2 gallon
    2. 1 gallon
    3. 1 1/2 gallons
    4. 2 gallons

5. Before gasoline will burn properly, it must be

    1. atomized and dried.
    2. atomized and compressed.
    3. atomized and ignited.
    4. atomized and mixed.

6. The fuel system delivers the fuel-air mixture FIRST to the

    1. intake manifold.
    2. engine.
    3. combustion chamber.
    4. valves.

7. The fuel pump has

    1. one check valve.
    2. two check valves.
    3. three check valves.
    4. four check valves.

8. The fuel pump pressure is determined by the

    1. diaphragm.
    2. diaphragm spring.
    3. actuating arm.
    4. check valves.

9. Dirt in the fuel system will cause excess wear to the fuel pump's

    1. diaphragm.
    2. actuating link pivot.
    3. diaphragm spring.
    4. check valves.

10. Which of the following is NOT used by car manufacturers for gasoline lines?

    1. Copper
    2. Steel
    3. Neoprene rubber
    4. Plastic

11. How many basic systems does the carburetor have?

    1. Four
    2. Six
    3. Eight
    4. Ten

12. The venturi is located in the

    1. fuel tank.
    2. fuel pump.
    3. carburetor.
    4. intake manifold.

13. The narrow, or constricted, air flow region in a carburetor increases the

    1. pressure.
    2. vacuum draw.
    3. spring pressure.
    4. float setting.

14. What carburetor system is in use while a vehicle is cruising at 50 M.P.H.?

    1. Idle/low speed
    2. Power
    3. Choke
    4. Main metering

15. The ideal air-fuel ratio for normal engine operation is

1. 11 to 1.
2. 13 to 1.
3. 15 to 1.
4. 19 to 1.

16. Depressing the accelerator pedal opens the

1. idle jet.
2. pump jets.
3. gas valve.
4. throttle valve.

17. Carburetor flooding is MOST often caused by

1. dirt between the needle and the seat.
2. a hole in the float.
3. a too high float level.
4. a bent float pivot pin.

18. A carburetor float that is set too high will cause

1. an overrich mixture.
2. a lean mixture.
3. a power increase.
4. better gas mileage.

19. In the cold weather, the accelerating system pump stroke should be

1. disconnected.
2. increased.
3. bent.
4. decreased.

20. If the high-speed nozzle is discharging gasoline with the engine idling, chances are that

1. the carburetor is functioning properly.
2. the float level is too high.
3. the choke valve is jammed open.
4. there is no current going to the anti-dieseling solenoid.

21. If the engine runs roughly through the idling to 25 M.P.H. range, chances are that the

1. idle/low-speed circuit is not functioning properly.
2. low-speed circuit is not functioning properly.
3. high speed circuit is not functioning properly.
4. idle circuit is not functioning properly.

22. To clean the paper air-cleaner element,

    1. wash it with kerosene.
    2. use compressed air.
    3. wash it with light engine oil.
    4. wash it with gasoline.

23. To clean the polyurethane air-cleaner element,

    1. wash it with acetone.
    2. use compressed air.
    3. wash it with oil.
    4. wash it with varsol.

24. Before installing the polyurethane air-cleaner element,

    1. make sure it is dry.
    2. dip it in engine oil and shake out the excess.
    3. dip it in engine oil and squeeze out the excess.

25. Possible causes of insufficient fuel delivery to the carburetor are

    1. a cracked diaphragm and excessive spring pressure.
    2. a cracked diaphragm and a sticking pump valve.
    3. an excessive bearing clearance and a worn pump rotor.

26. A high carburetor float level, worn jets, or a rich idle mixture can cause

    1. loss of power at high speeds.
    2. excessive fuel consumption.
    3. engine stalling after high-speed driving.
    4. None of the above

27. Lack of high speed engine performance could be caused by a

    1. stuck power piston, a clogged nozzle, or a low float level.
    2. choke valve jammed open, a clogged nozzle, or a high float level.
    3. worn nozzle, air leaks into the manifold, or high pump pressure.

28. A smoky, black, sooty exhaust is MOST likely due to

    1. a blown head gasket.
    2. excessive oil consumption.
    3. a worn piston.
    4. an excessively rich fuel-air mixture.

29. Failure of the engine to start unless primed is probably caused by trouble in the

    1. ignition system.
    2. starting system.
    3. lubricating system.
    4. carburetor.

30. One cause of engine stalling during warm up is the

    1. choke valve is not closing.
    2. choke valve is not opening.
    3. power valve is not opening.

31. Typical carburetor adjustments that can be made on a car include

    1. idle speed and high speed.
    2. pump pressure and choke.
    3. idle mixture and choke.
    4. choke and power.

32. To clean carburetor jets and circuits PROPERLY, use

    1. a solvent and compressed air.
    2. wire and compressed air.
    3. drills and solvent.
    4. wires and drills.

33. When servicing the carburetor,

    1. oil the automatic choke.
    2. replace the automatic choke.
    3. do not oil the automatic choke.

34. The damper in the thermostatically controlled air cleaner should start to open at a temperature between

    1. 20° and 40° F.
    2. 65° and 90° F.
    3. 85° and 115° F.
    4. 120° and 145° F.

Unit: THE LUBRICATING SYSTEM

Outline of Unit

I. Importance of the Lubricating System

II. Lubricating Oil

   A. Properties
   B. Classification

III. Components of the Lubricating System

IV. Operation of the Lubricating System

V. Lubricating System Service

VI. Replacement and/or Repair of Defective Components

Goal Statement

The automotive mechanic performs routine, periodic service to the engine's lubricating system. He diagnoses and identifies problems and corrects malfunctions related to the system in a safe and efficient manner. The mechanic has a working knowledge of tools and equipment used during service and repair of the lubricating system, is familiar with related technical publications and effectively communicates with fellow workers.

General and Specific Objectives

I. The student will understand the importance of the lubricating system. Specifically the student will be able to:

   A. state the purpose of the engine lubricating system.
   B. relate the possible results to an engine operating with a malfunctioning lubricating system.
   C. state the relationship of the lubricating system to other engine systems or components.
   D. given an engine chart, trace the flow of lubricating oil to the various parts of the engine.
   E. state the implications of air pollution to the lubricating system.

II. The student will understand the composition of lubricating oils. Specifically the student will be able to:

   A. define viscosity as it applies to the lubricating system.
   B. describe the effect of temperature on the lubricating oil.
   C. list the additives found in a quality oil, explaining the purpose of each.
   D. explain the refining process of lubricating oil.
   E. state the S.A.E. ratings of lubricating oil.
   F. explain the service ratings of lubricating oil.

III. The student will know sufficient manipulative skills related to the lubricating system. Specifically the student will be able to:

A. analyze the condition of an oil pump to determine its serviceability.
B. remove the oil filter and properly install a new unit.
C. determine the condition of an installed PCV valve.
D. given a specific vehicle, drain and refill the crankcase.
E. remove and replace an engine oil pan with a new pan gasket.

IV. The student will appreciate the necessary communicative skills related to the lubricating system. Specifically the student will be able to:

A. describe the engine lubricating system's operation.
B. given a list of technical terms, identify those pertaining to the lubricating system.
C. utilize manufacturer's terminology in describing trouble-shooting procedures.
D. given a list of technical terms, match the term with the correct definition.
E. given a diagram or unit of the total system, correctly label component parts and subassemblies using the manufacturer's terminology.
F. given gear and rotary oil pumps, describe the operation of each.
G. state the procedure to follow when the oil pressure light glows while driving.

V. The student will understand the systematic scheduled service to the lubricating system. Specifically the student will be able to:

A. list precautions which, if adhered to, will prolong system performance.
B. state the conditions that are most likely to result in crankcase sludge.
C. state the manufacturer's recommendations pertaining to the oil and filter change intervals.
D. given a variety of driving conditions, state the service rating of oil recommended for each condition.

VI. The student will understand the use of applicable tools and equipment. Specifically the student will be able to:

A. identify and properly use an oil filter wrench.
B. use thickness gauges to determine the condition of an engine oil pump.
C. install an external oil pressure gauge during trouble-shooting procedures.

VII. The student will understand lubricating system problems. Specifically the student will be able to:

A. diagnose lubricating system problems.
B. given a certain vehicle's symptoms, determine system malfunctions.
C. state the implications of high oil pressure.

D. state the implications of low oil pressure.
E. state the implications of no oil pressure.
F. select and connect applicable test equipment according to manufacturer's specifications.
G. describe the procedures to follow in investigating a customer's high oil consumption complaint.

VIII. The student will know how to repair or replace malfunctioning components safely and efficiently. Specifically the student will be able to:

A. identify safe shop procedures.
B. disassemble an engine oil pump for inspection.
C. reassemble an engine oil pump for service.
D. perform a shop disassembly of an oil pressure regulating valve.
E. reassemble an oil pressure regulating valve for service.
F. remove and replace the engine oil pressure switch.
G. remove and replace the oil pressure gauge.

TEST

1. The purpose of engine oil is to reduce friction, form a good seal, absorb shocks and

    1. burn with little residue.
    2. clean and cool the engine.
    3. improve gas mileage.
    4. extend spark plug life.

2. As the temperature rises on S.A.E. 30 oil, the viscosity of the oil

    1. increases.
    2. decreases.
    3. remains the same.

3. Which of the following describes oils of a LOWER viscosity when compared to oils of a higher viscosity?

    1. Thicker, or less fluid
    2. Thicker, or more fluid
    3. Thinner, or more fluid
    4. Thinner, or less fluid

4. The amount that the viscosity of oil changes with changing temperatures is indicated by its

    1. viscosity index.
    2. variability index.
    3. variability/viscosity index.
    4. temperature index.

5. Cranksase sludge is MOST likely to form during

   1. summer highway driving.
   2. winter highway driving.
   3. long trip driving.
   4. short trip driving.

6. An S.A.E. 20 oil is

   1. more viscous than S.A.E. 10 oil.
   2. less viscous than S.A.E. 10 oil.
   3. the same as S.A.E. 10 oil.

7. Considering service ratings, the recommended oil for short trip driving with a lot of starts and stops is

   1. ML oil.
   2. MC oil.
   3. MM oil.
   4. MS oil.

8. The USUAL recommendation is to change oil every

   1. month or 1000 miles, whichever occurs first.
   2. three months or 3000 miles, whichever occurs first.
   3. six months or 7000 miles, whichever occurs first.
   4. nine months or 9000 miles, whichever occurs first.

9. Squeeze-out resistance of lubricating oil, or its ability to stay in place in the engine bearings during compression refers to the oil's

   1. body.
   2. pour-point depressant.
   3. fluidity.
   4. viscosity index.

10. A GOOD lubricating oil must have the proper viscosity and adequate resistance to

    1. oxidation, carbon formation and sludge formation.
    2. foaming, burning and sludge formation.
    3. foaming, carbon formation and oxidation.
    4. carbon formation, cooling and oxidation.

11. If you have been using MS oil, under the new classification you will use

    1. CD oil.
    2. SB oil.
    3. SA oil.
    4. SD oil.

12. In the new classification system, the "D" prefix stands for

    1. depressant.
    2. diesel engine.
    3. density.
    4. detergent.

13. A GOOD place to connect a master gauge to check oil pressure is at the

    1. oil light sender port.
    2. rocker shaft.
    3. timing cover.
    4. oil pan.

14. Noisy hydraulic lifters indicate

    1. high oil pressure.
    2. aerated oil.
    3. improper valve timing.
    4. improper ignition timing.

15. Which of the following oil pump components is free to "float" in the housing bore?

    1. Drive gear
    2. Inner rotor
    3. Outer rotor
    4. All of the above

16. Three classifications of friction are

    1. dry, greasy and viscous.
    2. dry, wet and liquid.
    3. dry, liquid and solid.
    4. dry, greasy and oily.

17. Causes of excessive engine oil pressure include

    1. stuck relief valve, heavy oil, or worn engine bearings.
    2. stuck pressure indicator, stuck relief valve, or low oil level.
    3. heavy oil, worn engine bearings, clogged oil line.
    4. clogged oil line, stuck relief valve, or heavy oil.

18. If the oil filter feels hot after it has been operating a SHORT time then probably the

    1. oil flow is normal.
    2. relief valve is not working.
    3. oil pressure is high.
    4. oil pressure is low.

19. A sticking crankcase ventilation valve causes

    1. excessive oil consumption and overheating.
    2. poor idling and stalling.
    3. crankcase sludge and overheating.
    4. blow-by and poor idling.

20. In the closed-crankcase ventilating system, crankcase vapors are delivered to the

    1. atmosphere.
    2. intake manifold.
    3. exhaust manifold.
    4. purifier.

21. Causes of low engine oil pressure include

    1. stuck oil pump relief valve, heavy oil, or worn engine bearings.
    2. stuck pressure indicator, heavy oil, or low oil level.
    3. worn engine bearings, thin oil, or low oil level.
    4. stuck oil pressure relief valve, thin oil or clogged oil line.

22. The two basic types of oil pumps are the

    1. rotor and diaphragm.
    2. gear and diaphragm.
    3. gear and rotor.
    4. diaphragm and piston.

23. The oil pressure relief valve, which opens to relieve excessive pressure, may contain either a

    1. plunger or ball.
    2. diaphragm or lever.
    3. plunger or rod.
    4. diaphragm or ball.

24. There is a bypass valve in

    1. the bypass filter assembly.
    2. the even flow filter assembly.
    3. all of the oil filter assemblies.
    4. the full flow filter assembly.

25. The two basic types of electrical oil pressure indicators are the

    1. pressure-expansion and thermostatic.
    2. balancing-coil and thermostatic.
    3. full-flow and balancing-coil.
    4. balancing-coil and pressure-expansion.

26. The two MAIN factors affecting oil consumption are

    1. engine speed and temperature.
    2. worn engine parts and temperature.
    3. engine oil level and speed.
    4. worn engine parts and speed.
    5. engine oil level and temperature.

27. A MAJOR cause of oil loss from an engine is

    1. crankcase dilution.
    2. burning in the combustion chamber.
    3. burning in the crankcase chamber.
    4. oil vapors escaping to the atmosphere.

28. Two basic types of lubricating systems are the

    1. splash and oil nozzle feed.
    2. splash and bypass.
    3. pressure feed and vacuum.
    4. combination splash and pressure feed.

29. The purpose of the oil pressure relief valve in the pressure feed system is to

    1. assure adequate pressure.
    2. prevent excessive pressure.
    3. prevent insufficient lubrication.
    4. assure adequate oil circulation.

30. The use of a compression and/or cylinder leak gauge will determine the

    1. crankshaft bearing wear.
    2. valve lifter operation.
    3. ring wear.
    4. valve stem guide wear.

31. Which of the following does NOT apply? Glowing of the oil pressure warning light may be followed by

    1. crankshaft bearing failure.
    2. camshaft bearing failure.
    3. water pump failure.
    4. piston ring failure.

32. Disposable, screw-on filters should be installed and tightened

    1. with a strap wrench.
    2. by hand, 3/4 to 1 turn after the gasket makes contact.
    3. with a pipe wrench.
    4. By any of the above methods

33. The BEST definition of viscosity is

    1. weight.
    2. pounds per square inch.
    3. API service classification.
    4. ability to resist flowing.

34. Water sludge forms in the crankcase from the mixing of

    1. water and fuel.
    2. water and gas.
    3. water and oil.
    4. water and air.

35. LOW oil pressure could be due to

    1. a strong relief valve spring.
    2. high pump speed.
    3. tight engine bearings.
    4. worn engine bearings.

36. Oil bleed holes are used in connecting rods to

    1. lubricate the piston pin.
    2. control air flow through the bearings.
    3. control maximum oil pressure.
    4. prevent oil leakage from the engine.

37. Oil feed holes are placed in main bearings at the

    1. highly loaded portion.
    2. lightly loaded portion.
    3. most convenient location.
    4. end of the oil passage.

38. An EXCESSIVE amount of oil coming out of the oil filler cap indicates

    1. high oil pressure.
    2. high crankcase pressure.
    3. a defective pressure relief valve.
    4. a clogged oil filter.

39. The maximum viscosity of engine oil is limited by the

    1. engine's horsepower.
    2. engine's ability to crank when cold.
    3. oil's thin fluid body.
    4. engine's maximum operating temperature.

40. When selecting a suitable engine oil, it is necessary to consider the viscosity and the

    1. thickness.
    2. oil additives.
    3. API service classification.
    4. cold cranking characteristics.

41. To prevent or reduce aerated oil in the engine, modern oils contain a small amount of chemical additive called

    1. foam inhibitor.
    2. detergent dispersant.
    3. oxidation inhibitor.
    4. corrosion and rust inhibitor.

42. Distillation is a process of obtaining which of the following from crude oil?

    1. Gasoline and fuel oil
    2. Kerosene and heating fuel
    3. Thinners and solvents
    4. Lubrication oil and grease
    5. All of the above

43. The purpose of crankcase ventilation is to

    1. remove liquid gasoline and water.
    2. remove vaporized gasoline and water.
    3. cool the oil.
    4. supply oxygen to the crankcase.

44. A bearing leak detector can be used to check bearing clearance. Which of the following oil run-off from bearings indicates excessive clearance?

    1. No run-off
    2. 20-25 drops per minute
    3. A steady stream
    4. All of the above

45. Should the oil pressure light glow while driving,

    1. stop the car and check for oil leaks while the engine is running.
    2. it is not necessary to do anything.
    3. stop the car and the engine to check the oil level.
    4. stop the car and check the oil level while the engine is running.

46. To determine the condition of a PCV valve, remove the oil filler cap, start the engine and place a piece of paper over the oil filler. A properly operating PCV valve should

    1. hold the paper to the oil filler.
    2. blow the paper away from the oil filler.
    3. draw the paper into the oil filler.
    4. have no effect on the paper.

47. Which of the following may lead to an early breakdown of the lubricating system?

    1. Checking the oil level every month only
    2. Changing the oil every three months
    3. Changing the oil filter every six months
    4. Replacing the PCV valve every year

Items 48-54 require actual shopwork and the use of special tools. Follow the instructor's directions to comply with the following:

48. Disassemble, inspect and reassemble a typical gear oil pump.

49. Disassemble, inspect and reassemble a typical rotor oil pump.

Perform the following:

50. Remove the oil filter and install a new unit.

51. Drain and refill crankcase.

52. Remove and replace an engine oil pan using new pan gasket.

53. Remove and replace engine oil pressure switch.

54. Remove and replace oil pressure gauge.

Unit: THE COOLING SYSTEM

Outline of Unit

I. Introduction
   - A. Warm-up
   - B. Normal operation
   - C. Cold operation

II. Cooling System Types
   - A. Air-cooled systems
   - B. Liquid-cooled systems

III. Water Jackets

IV. Water Pump
   - A. Seals
   - B. Shaft and bearing
   - C. Pump body

V. Fan
   - A. Variable speed
   - B. Flexible

Goal Statement

The automotive mechanic successfully trouble shoots, makes component repair or replacement decisions concerning the cooling system as encountered in the service setting and follows this with corrective action. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the use and utilization of technical publications, service manuals, service bulletins, flat rate time manuals. He also must be able to communicate effectively with other service personnel.

General and Specific Objectives

I. The student will recognize the parts of the cooling system. Specifically the student will be able to:
   - A. identify the component parts of a liquid cooled system.
   - B. identify the component parts of an air cooled engine.
   - C. given a specific radiator pressure cap, test to see if it meets manufacturer's specifications.
   - D. given a thermostat, determine if it meets the manufacturer's specifications.

II. The student will know the various types of cooling systems. Specifically the student will be able to:

  A. inspect radiator hoses for cracks and leaks.
  B. given the manufacturer's service manual's recommended procedures, determine if there are any internal or external coolant leaks.
  C. given an anti-freeze hydrometer, adjust it to recommended temperature protection and determine radiator coolant anti-freeze content.
  D. select appropriate protective clothing and goggles when using cleaning equipment.

III. The student will understand the function of each component of the cooling system. Specifically the student will be able to:

  A. given a specific automobile and the manufacturer's specifications, adjust the fan belt.
  B. reverse flush cooling systems to clean them.
  C. given an automobile with a leaking water pump, correct the problem.
  D. given an automobile with a blocked radiator, remove and clean it.

IV. The student will understand how to service, repair or replace cooling system components. Specifically the student will be able to:

  A. list and explain the types of engine fans.
  B. perform cooling system service.
  C. given specific thermostat problems, diagnose the difficulty.
  D. given a model, trace the circulation of coolant in the cooling system.
  E. given an automotive service manual, select the specifications for various radiator pressures.
  F. given a specific vehicle's service manual, select the correct thermostat heat range.

V. The student will understand how to diagnose cooling system problems. Specifically the student will be able to:

  A. given an overheating automobile, diagnose and correct the problem.
  B. given an air cooled vehicle, correctly diagnose the passenger compartment heater failure.
  C. given parts that have been diagnosed as not usable, correctly order replacement parts.

VI. The student will understand how to communicate with customers. Specifically the student will be able to:

  A. explain shop procedures and policies to customers who have questions or complaints.
  B. explain trouble shooting procedures to customers in relation to service charges.
  C. explain the benefits of installing rebuilt components instead of shop repairing defective units.

TEST

1. Which of the following is an INCORRECT method of inspecting a radiator pressure cap?

    1. Check the cap seal in the filler neck for deposits of foreign matter
    2. Check the rubber seal on the cap to see if it is hard and swollen
    3. Compress the coil spring to force the cap seal onto the radiator filler neck
    4. Check the circulation of the entire system
    5. All of the above

2. Present-day cooling systems are pressurized to

    1. allow limited circulation.
    2. force more coolant through the engine.
    3. raise the boiling point of the coolant to permit higher engine operating temperatures.
    4. reduce the amount of coolant required in the system.
    5. All of the above

3. When checking the coolant level in a pressurized system, automotive manufacturers warn against all EXCEPT which of the following?

    1. Frequent removal of the radiator cap while the engine is warm
    2. Removal of the cap when the engine is hot
    3. Removal of the cap when the engine is running
    4. Adding cold coolant to a system when it is excessively hot
    5. Removal of the cap when the engine is cool

4. When testing the "freeze-protection" of the coolant with a hydrometer, the

    1. engine may be running.
    2. engine and coolant must be cold.
    3. engine and coolant must be hot.
    4. engine and coolant may be either hot or cold.
    5. All of the above

5. Most car manufacturers recommend the year-round use of a coolant solution consisting of

    1. methyl alcohol.
    2. plain water.
    3. alcohol and water.
    4. ethylene glycol and water.
    5. Any of the above

6. A defective thermostat stuck in the open position should be replaced because

    1. it will not allow an engine to warm up properly.
    2. it will not allow the coolant to circulate.
    3. it will cause the engine to overheat.
    4. it will cause the engine to boil.
    5. None of the above

7. When reverse-flushing an engine block,

    1. it is necessary to remove the thermostat.
    2. it is necessary to remove water pump.
    3. the air pressure should be applied in short spurts.
    4. it is necessary to operate the engine at 1500 RPM.
    5. All of the above

8. Engine overheating can be caused by

    1. adding more coolant to the system from time to time.
    2. late ignition timing.
    3. the thermostat being stuck in the open position.
    4. the manifold heat control valve being stuck in the open position.
    5. All of the above

9. The BEST procedure to clean the cooling system properly is the

    1. removal and disassembly method.
    2. chemical method, if either a slight rust or an oil film is found.
    3. chemical method, if heavy deposits of rust and scale are found.
    4. reverse flush method, if an oil film is found.
    5. None of these

10. Slow engine warm-up may be a cooling system difficulty which can be caused by

    1. a defective cooling system thermostat.
    2. a defective by-pass hose.
    3. a defective water jacket.
    4. the cylinder head bolts needing to be tightened.
    5. using too much anti-freeze.

11. Fan, generator and power steering belts should always be replaced

    1. at every engine tune-up.
    2. when frayed, cracked, worn or greasy.
    3. when cleaning the cooling system.
    4. at the same time, even if they are not matched belts.
    5. All of the above

12. Partial coolant circulation in the engine block when the engine is cold is provided by

    1. manifold heat control valve.
    2. fan.
    3. thermostat.
    4. by-pass.
    5. water pump.

13. Compression leakage into the cooling system is caused by

    1. a leaky water pump.
    2. loose hose clamps.
    3. a cracked radiator hose.
    4. a defective head gasket.

14. When using the cooling-system pressure tester, apply a pressure of

    1. 5 P.S.I.
    2. 24 P.S.I.
    3. 15 P.S.I.
    4. 10 P.S.I.
    5. Any of the above

15. Which of the following is at fault when the water pump suddenly starts to leak?

    1. Drain hold
    2. Impeller
    3. Shaft bearing race
    4. Shaft seal
    5. Pump shaft

16. The major components of the engine cooling system are the water pump, engine water jackets, the engine fan and

    1. the thermostat and the crankcase.
    2. the thermostat and the radiator.
    3. the manifolds and the thermostat.
    4. the thermostat and the crankshaft.

17. The major components of an air cooling system are the cooling air control valve, finned metal heat sinks and the

    1. thermostat.
    2. hoses.
    3. radiator.
    4. exhaust ducts.
    5. All of the above

18. Why are safety glasses desirable when working on an automobile?

    1. To help see more clearly
    2. To prevent eye strain
    3. To prevent eye injury
    4. All of the above

19. When returning INCORRECT parts to an automotive supply store for credit, it is also necessary to take

    1. the purchaser's copy of the bill.
    2. all the old parts.
    3. the vehicle for which the parts are needed.
    4. information concerning the year of the vehicle.
    5. All of the above

For items 20-25, determine whether the cooling system components displayed by your instructor are usable or need to be replaced. If usable, mark "U"; if not usable, mark "N".

20. Silicon hub fan drive

21. Water pump

22. Thermostat

23. Fan belt

24. Radiator hose (upper or lower)

25. Radiator assembly

26. If the needle of the pressure tester fluctuates with the engine running at half throttle, chances are there is

    1. an air leak into the cooling system.
    2. a cracked engine block.
    3. a defective head gasket.
    4. All of the above

27. If air is sucked into the cooling system,

    1. the water will foam and overflow.
    2. corrosion will result.
    3. the cylinder head gasket should be replaced.
    4. All of the above

28. Checking for compression leakage into the cooling system requires

    1. removal of the thermostat and cylinder head.
    2. removal of the thermostat and fan belt.
    3. a pressure tester.
    4. All of the above

29. If the engine radiator freezes, overheating in the cooling system

    1. cannot occur.
    2. may occur at times.
    3. All of the above
    4. None of the above

30. Most water pumps have

    1. ball bearings that require periodic lubrication.
    2. sealed ball bearings that require no lubrication.
    3. a relief valve that requires periodic replacement.
    4. All of the above

31. A cooling system thermostat designated as a 180° F. unit will

    1. start to open at 177° to 182° F.
    2. be fully open at 177° to 182° F.
    3. start to open at 160° F.
    4. All of the above

32. With permanent or glycol antifreeze, it is necessary to

    1. use a 160° F. thermostat.
    2. not use a thermostat.
    3. use a 180° to 200° thermostat.
    4. All of the above

33. If a pressure cap produces 15 pounds of pressure in a cooling system, then the boiling point of the water will be raised to

    1. 215° F.
    2. 230° F.
    3. 250° F.
    4. 260° F.

34. Radiators can be classified as

    1. side flow and flow through.
    2. up flow and down flow.
    3. down flow and cross flow.
    4. All of the above

35. The water from the engine's water jackets

    1. goes through the pump to the radiator.
    2. moves up through the radiator.
    3. moves down through the radiator.
    4. All of the above

36. The purpose of the variable speed fan drive is to

    1. improve cooling efficiency at high speeds.
    2. reduce power requirements at low speeds.
    3. reduce power requirements at medium and high speeds.
    4. All of the above

37. If a vehicle is overheating, it is necessary to first check the

    1. thermostat operation.
    2. water pump output.
    3. radiator pressure cap.
    4. fan belt adjustment.
    5. level of coolant.
    6. All of the above

38. A pressure cap is used on the radiator in most automotive cooling systems to

    1. prevent the loss of coolant through overflow if the vehicle is brought to a quick stop.
    2. keep air out of the cooling system at all times.
    3. raise the boiling point of the coolant.
    4. maintain a constant operating temperature.

39. The by-pass valve in the cooling system prevents

    1. pressure buildup in the radiator.
    2. fast warm up of the engine block.
    3. the top radiator hose from blowing off.
    4. pressure buildup in cylinder block until the thermostat opens.
    5. pressure buildup in the heater core.

40. The thermostat on an emission controlled engine would MORE likely be wide open after prolonged

    1. idling in traffic.
    2. driving at sustained highway speeds.
    3. engine operation at high RPM.
    4. All of the above

41. The MOST critical heat transfer limiting point of a liquid cooling system is between the

    1. block and the coolant.
    2. head and the coolant.
    3. coolant and the radiator.
    4. radiator and the air.
    5. All of the above

42. When the thermostat is closed, coolant will always flow through the

    1. radiator.
    2. heater core.
    3. by-pass.
    4. atmospheric valve.
    5. All of the above

43. A water pump seal may leak

    1. air.
    2. water.
    3. oil.
    4. All of the above

44. Under pressure, water boils at a

    1. higher temperature.
    2. lower temperature
    3. All of the above
    4. None of the above

45. In addition to providing greater capacity, what is the purpose of an auxiliary tank?

    1. To provide transmission cooling
    2. To act as an expansion chamber
    3. To connect the engine to the radiator
    4. All of the above

46. How much of the heat energy in the fuel must be handled by the cooling system?

    1. One-half
    2. One-third
    3. One-fourth

47. The water pump is driven from the

    1. camshaft.
    2. engine fan.
    3. crankshaft timing gear.
    4. crankshaft pulley.

48. The types of anti-freeze are alcohol base and

1. heptane.
2. ethylene glycol.
3. tetraethyl.
4. octane.

Unit: THE IGNITION SYSTEM

Outline of Unit

I. Ignition Circuits

- A. Primary circuit
- B. Secondary circuit

II. Advance Mechanisms

III. Ignition Timing

IV. Tools and Test Equipment

V. Safety

Goal Statement

The automotive mechanic successfully trouble shoots, makes component repair or replacement decisions concerning the ignition system as encountered in the service setting and follows this with corrective action. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manuals and be able to effectively communicate with other service personnel.

General and Specific Objectives

I. The student will understand the importance of a properly operating ignition system to the overall efficiency of the engine. Specifically the student will be able to:

- A. state the reasons for poor gasoline mileage resulting from malfunctions in the ignition system.
- B. list some of the possible problems resulting from malfunctions in the ignition system.
- C. compare a poorly operating ignition system to one that is operating properly.
- D. explain why each component ignition system is dependent upon the other for overall efficiency of the engine.

II. The student will understand how to use the correct technical terms related to the ignition system. Specifically the student will be able to:

- A. given an assortment of parts, label them with the correct technical terms.
- B. given a list of technical terms, match them with the correct definitions.

C. given a diagram of an ignition system, label each part using correct technical terms.
D. use correct terminology in the discussion and testing of the ignition system components.

III. The student will understand the importance of knowing how to perform all required testing and repairs safely. Specifically the student will be able to:

A. given an ignition system incorporating a cracked distributor cap, diagnose this difficulty using proper tools and equipment.
B. given a dwell meter, demonstrate its use while observing all safety precautions.
C. given a timing light, check ignition timing observing all safety precautions.
D. given an ignition switch, install this component observing all safety precautions.
E. given a distributor, overhaul this component observing all safety precautions.

IV. The student will efficiently interpret both diagnosis results and parts replacement procedures necessary for proper repairs of the ignition system. Specifically the student will be able to:

A. complete tune-up chart diagnosis steps correctly.
B. list repair parts by the correct names.
C. list the step-by-step procedure for a minor tune-up.
D. given a compression gauge, correctly perform a compression test on all cylinders and interpret the results.
E. given an ignition system with a misfiring cylinder, diagnose the problem.
F. given a specific ignition system problem, relate the problem and intended corrective procedure to the customer.

V. The student will comprehend the construction, operation and function of the ignition system. Specifically the student will be able to:

A. given a list of malfunctions in the ignition system, state their probably cause.
B. explain the operation of the distributor.
C. describe the function of the condenser in the ignition system.
D. given an ignition system simulator, trace each circuit.
E. describe the construction of the ignition coil.
F. identify the parts in the primary circuit.
G. identify the parts in the secondary circuit.
H. explain the purpose of the by-pass resistor.
I. given an ignition coil, explain how battery voltage is boosted to more than 20,000 volts.
J. given a vacuum advance unit, describe its function in relation to the distributor and engine timing.
K. state the types of transistor ignition systems and how they function.

VI. The student will understand the importance of knowing how to efficiently repair, replace, or service any given part of the ignition system. Specifically the student will be able to:

A. install ignition points and condenser.
B. correctly install a distributor assembly in the engine.
C. replace an ignition harness.
D. given the manufacturer's specifications, set ignition timing.
E. replace a vacuum advance unit.
F. clean and adjust a set of spark plugs.
G. given a misfiring engine, select the tools and equipment for proper diagnosis.
H. given a distributor assembly, test and adjust to manufacturer's specifications on a distributor machine.
I. install an ignition coil observing proper polarity precautions.
J. given the manufacturer's specifications, use a timing light to set ignition timing.
K. replace defective transistor ignition system components.

VII. The student will understand the importance of knowing how to perform all tests, adjustments and repairs to the ignition system at a rate which meets industry standards. Specifically the student will be able to:

A. given a flat rate manual, determine the charge rates for various repairs to the ignition system.
B. given a repair order, compute repair charges to the ignition system.
C. explain profit loss due to customer "comebacks" resulting from poor workmanship.

TEST

1. A fouled or improperly adjusted spark plug contributes to poor gas mileage because

   1. the fuel is not completely burned within the cylinder.
   2. the secondary voltage will be lowered.
   3. the ignition timing will be retarded.
   4. the spark plug must fire twice in order to burn the fuel.

2. The engine's lack of power can be the fault of

   1. an improperly adjusted fan belt.
   2. a defective vacuum control.
   3. a dirty oil filter.
   4. a missing air filter.
   5. a burned out muffler.

3. Using an oscilloscope with an engine that is operating PROPERLY all spark plug spikes should be

   1. within 25KV of each other.
   2. within 10KV of each other.
   3. within 10KV above or below the plug firing line.
   4. even, not to exceed 45KV.
   5. within 3KV of each other below the plug firing line.

4. The purpose of a condenser is to

   1. absorb all the high voltage from the coil.
   2. reduce arcing at the breaker points.
   3. time the firing impulse to the spark plug.
   4. intensify the amperage.
   5. All of the above

5. The primary circuit starts at the battery and continues through the

   1. solenoid, resistor, ignition switch, coil and points to ground.
   2. coil, ignition switch, resistor and points to ground.
   3. ignition switch, resistor, coil and points to ground.
   4. resistor, ignition switch, coil and points to ground.

6. The ignition coil is constructed in which of the following ways?

   1. Soft iron coil, primary winding, secondary winding and filled with oil
   2. Hard iron core, primary winding, secondary winding and filled with oil
   3. Laminated core and 300 turns of large wire
   4. 3000 turns of fine wire and filled with sodium
   5. 38,000 turns of #16 wire around a wooden dowel

7. Which of the following is considered the primary circuit?

   1. Battery, starter, solenoid, ignition switch, coil primary and points
   2. Battery, ignition switch, resistor, coil primary, points and condenser
   3. Battery, resistor, rotor, condenser and points
   4. Battery, starter, distributor, resistor and ignition points

8. Which of the following is considered the secondary ignition circuit?

   1. Battery, solenoid, distributor, rotor, plugs and plug wires
   2. Coil secondary, condenser, distributor cap, rotor, plugs and plug wires
   3. Battery, starter, distributor, coil, secondary plugs and plug wires
   4. Coil secondary, rotor, distributor cap, plug wires and plugs

9. The purpose of the by-pass resistor is to

   1. reduce battery voltage in the primary circuit from 12 volts to 6-9 volts.
   2. by-pass current from the primary circuit to the starting circuit.
   3. prevent too high a charging rate from entering the primary circuit.
   4. reduce coil output under a load.
   5. protect the diodes in the alternator.

10. The ignition coil can increase battery voltage as high as

    1. 250 volts.
    2. 1500 volts.
    3. 5000 volts.
    4. 35,000 volts.
    5. 60,000 volts.

11. The vacuum advance unit will advance the timing when

    1. the vehicle is decelerating.
    2. the vehicle is under a light load only.
    3. the intake manifold vacuum increases.
    4. the vehicle is running at top speed with wide open throttle.
    5. the vehicle is descending a hill, throttle closed.

12. A defective connection in the primary circuit will result in

    1. the resistor overheating.
    2. a low charging rate.
    3. dim headlights.
    4. low boosted voltage at the spark plugs.

13. In addition to other vital functions, the distributor

    1. drives the fuel pump.
    2. houses and operates the breaker points.
    3. distributes oil to the rocker arms.
    4. drives the camshaft.

14. Static timing means

    1. timing with a vacuum gauge.
    2. retarding the timing at idle.
    3. advancing the timing at idle.
    4. timing with the engine not running.

15. The principal ADVANTAGE of the capacitor discharge system compared to the conventional system is that

    1. it has the ability to fire fouled plugs.
    2. the initial cost is much less.
    3. it is easier to repair.
    4. it eliminates the use of a coil.

16. One of the ADVANTAGES of transistor ignition systems is that

    1. the load on the condenser is much less.
    2. the coil operates at a lower temperature.
    3. resistor plugs are not required.
    4. the electrical load on the points is lower.

17. The capacitor discharge ignition system

    1. uses a capacitor in place of a coil.
    2. eliminates all arcing across the points.
    3. increases voltage with a longer rise time
    4. discharges a capacitor to the coil primary circuit.

18. In which of the solid state ignition systems is the dwell not adjustable?

    1. Transistorized ignition
    2. Capacitor discharge ignition
    3. Contact controlled transistor ignition
    4. Magnetic pulse transistor ignition

19. To protect the components in the transistor ignition system a

    1. heat dam is used.
    2. heat baffle is used.
    3. heat shield is used.
    4. heat sink is used.

20. The principal ADVANTAGE of the magnetic pulse transistor ignition is that

    1. it is more economical.
    2. it has fewer parts.
    3. it eliminates the contact points.
    4. it provides lower coil temperatures.

21. A transistor is basically

    1. a special type of diode.
    2. a magnetic pulse generator.
    3. a device to limit current flow.
    4. an electronic switching unit.

22. The purpose of the resistor built into some spark plugs is to

    1. reduce wear on the points.
    2. reduce radio and TV interference.
    3. improve high-speed performance.
    4. prolong spark plug life.

23. The order in which the spark plugs fire is established by the order in which the

    1. plugs are mounted in the engine.
    2. contact points open.
    3. plug leads are connected to the cap.
    4. pistons reach top center.

24. The rotor transmits current between the

    1. primary winding and the plugs.
    2. secondary winding and the plugs.
    3. primary winding and the battery.
    4. distributor cap and the primary winding.

25. The centrifugal advance mechanism advances the

    1. breaker plate and points.
    2. breaker cam and rotor.
    3. distributor cap and rotor.
    4. breaker plate and rotor.

26. A cracked spark plug porcelain is usually caused by

    1. spark rap in the engine.
    2. an improper heat range.
    3. excessive operating temperature.
    4. careless installation.

27. Adjust point contact alighment by bending the

    1. pivot post.
    2. contact plate.
    3. stationary point bracket.
    4. movable point arm.

28. Dwell angle or cam angle means the

1. angle at which the rubbing block contacts the cam.
2. angle between the lobes on the cam.
3. degree of rotation at which the points are closed.
4. degree of rotation at which the points are open.

29. Firing order means the

1. direction that the distributor turns.
2. sequence in which the cylinders are numbered.
3. sequence in which the cylinders fire.
4. order in which the pistons reach top dead center.

30. Coil polarity can be reversed by

1. installing a different condenser.
2. reversing the coil-to-distributor secondary wire.
3. reversing the spark plug cables.
4. reversing the primary coil wire connections.

31. Increasing the contact point gap

1. increases the dwell angle.
2. retards ignition timing.
3. decreases the dwell angle.
4. raises the coil saturation time.

32. The color of normally worn ignition points is

1. deep blue.
2. reddish brown.
3. dull grey.
4. silvery.

33. Which of the following parts in the distributor most often requires replacement?

1. Cap
2. Points
3. Rotor
4. Advance mechanism

34. The vacuum advance mechanism advances ignition timing according to the

1. engine speed.
2. engine load.
3. road speed of vehicle.
4. None of the above

35. The spark plugs' heat range is determined by the

    1. plug voltage.
    2. direction of current flow.
    3. length of plug cables.
    4. length of insulator.

36. Spark plugs should be torqued to

    1. insure proper heat transfer.
    2. prevent stress breakage.
    3. secure a proper seal.
    4. All of the above

37. A spark plug that is too cold for the operating conditions of an engine should be replaced by one which has a

    1. smaller diameter.
    2. longer insulator nose.
    3. shorter insulator nose.
    4. larger insulator top.

38. Which of the following is NOT a part of the ignition system?

    1. Coil
    2. Points
    3. Solenoid
    4. Distributor

39. INCORRECT coil polarity causes

    1. higher plug temperatures.
    2. lower voltage to plugs.
    3. shorter point life.
    4. higher secondary voltage.

40. The primary ignition resistor is designed to

    1. allow higher flow at high speeds.
    2. protect the primary circuit.
    3. allow higher flow at low speeds.
    4. protect the secondary circuit.

41. Which of the following is in the primary circuit?

    1. Spark plug
    2. Rotor
    3. Points
    4. Distributor cap

42. Which of the following statements is TRUE concerning the two windings of the ignition coil?

    1. The primary winding has more turns.
    2. The secondary winding has heavier wire.
    3. Both windings have the same number of turns.
    4. The secondary winding has many more turns than the primary.

43. The ignition condenser is connected across the

    1. coil secondary.
    2. coil primary.
    3. contact points.
    4. battery.

44. When the contact points are closed, the voltage in the condenser

    1. goes up.
    2. is zero.
    3. is near its peak.
    4. drops slightly.

45. Normal breaker contact point rubbing block wear causes

    1. the timing to advance.
    2. shorter coil saturation time.
    3. the timing to retard.
    4. lower coil output.

46. Decreasing point gap

    1. increases dwell.
    2. decreases dwell.
    3. has no effect on dwell.

47. While some ignition advance mechanisms use manifold vacuum, others may use

    1. atmospheric pressure.
    2. a venturi vacuum.
    3. a fuel pump vacuum.
    4. None of the above

48. Which of the following is the LEAST accurate statement regarding burned or pitted contact points?

    1. High primary voltage
    2. Excessive condenser resistance
    3. Under-capacity condenser
    4. Spark plug heat range too hot

In items 49-56 select the proper response from the list of technical terms A-F appearing to the right of the page which best satisfies the definition. Place your answer choice in the blank to the left of the definition. An answer may be used more than once or not at all.

DEFINITION

__49. Opposition to flow of electric current
__50. Movement of electrons within a conductor
__51. Maximum voltage available at the coil output tower
__52. A loss of current due to excessive resistance
__53. An incomplete path for current flow
__54. An unintentionally completed circuit through which battery current will flow
__55. Completing a circuit, as with a headlight switch
__56. Voltage which is available from the coil under load

TECHNICAL TERM

A. Voltage drop
B. Resistance
C. Current flow
D. Boosted voltage
E. Reserve voltage
F. Ground circuit

In items 57-63 select the proper response from the list of ignition system components A-G appearing to the right of the page which best satisfies the definition. Place your answer choice in the blank to the left of the definition. An answer may be used more than once or not at all.

DEFINITION

__57. Distributes high voltage in proper sequence to the spark plugs
__58. Reduces ignition noise interference in automobile radios
__59. Reduces voltage in the primary circuit
__60. Steps up battery voltage to fire the spark plugs
__61. Distributes high voltage secondary current to the proper plug wire
__62. Identifies high voltage or boosted voltage in the system
__63. Identifies low voltage or battery voltage in the system

IGNITION SYSTEM COMPONENTS

A. Ignition coil
B. Resistor unit
C. TVR suppressor cable
D. Primary circuit
E. Rotor
F. Distributor cap
G. Secondary circuit

Unit: THE STARTING SYSTEM

Outline of Unit

I. Fundamentals of Electricity and Magnetism

II. The Storage Battery

III. Battery Cables

IV. Cranking Motors

V. Related System Components

Goal Statement

The automotive mechanic successfully trouble shoots, makes component repair or replacement decisions concerning the starting system as encountered in the service setting and follows this with corrective action. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manuals, and be able to communicate effectively with other service personnel.

General and Specific Objectives

I. The student will understand the theory, design features and terms related to basic electricity and starting systems. Specifically the student will be able to:

   A. given a drawing of the starting system, identify each part.
   B. given a drawing of the starter, trace the current flow.
   C. given pictures of a Delco, an Autolite Ford, and a Chrysler starter, list the distinguishing features of each.
   D. draw and label the starting system.
   E. given the necessary materials, demonstrate a permanent magnet.
   F. given the necessary materials, demonstrate a non-permanent magnet.
   G. given two dissimilar metals, wire, and galvanometer, construct a battery, using the proper chemicals.
   H. recognize the technical terminology related to the starting system.
   I. recognize the technological features of each component of the starting system.
   J. list three ways electricity is produced in the automobile.
   K. recognize different types of electrical circuitry.

II. The student will understand the importance of safe working practices while performing tests and repairs to the starting system. Specifically the student will be able to:

- A. list types of clothing that shouldn't be worn in the shop.
- B. list the safety precautions to observe while removing and replacing a battery.
- C. list the physical and mechanical safety precautions to observe when cleaning a typical inoperative starter.
- D. demonstrate the physical and mechanical safety precautions to observe when trouble shooting the starting system.

III. The student will recognize the problems related to each component in the starting system. Specifically the student will be able to:

- A. locate starting system problems using the proper tools and test equipment.
- B. use the special equipment needed for testing starting system components.
- C. explain why a battery with low capacity will not start a large engine on a cold morning.
- D. state why cranking voltage must be above a predetermined minimum.
- E. explain why a starter that is drawing too much current can cause starting to be difficult.

IV. The student will interpret all tests performed on the system. Specifically the student will be able to:

- A. given a battery, hydrometer and capacity tester, analyze all data and make a corrective recommendation.
- B. given a starter diagnosis sheet, analyze all data and make a corrective recommendation.
- C. given a battery cable and ohmmeter, test cable resistance to determine whether or not it is serviceable.
- D. given a test light and a specific vehicle, conduct continuity tests at each junction involving the starting system.
- E. given a solenoid and ohmmeter, perform a winding check and compare to factory specifications.

V. The student will understand the importance of acquiring knowledge and skill to perform assigned tasks at a rate of time meeting entrance level industry standards. Specifically the student will be able to:

- A. given a starter, proper replacement parts and tools, overhaul the unit in the time allowed in the flat rate manual.
- B. install a typical solenoid in the time allowed in the flat rate manual.
- C. given a voltmeter and ampmeter, conduct current draw and voltage tests in the time allowed in the flat rate manual.
- D. properly adjust a neutral safety switch in the time allowed in the flat rate manual.

TEST

1. The first natural magnet was called

    1. the lodestone.
    2. a temporary magnet.
    3. a permanent magnet.
    4. the freestone.

2. The difference in electrical pressure between two poles of a battery is called

    1. amperes.
    2. ohms.
    3. volts.
    4. resistance.

3. The amount of resistance of a wire does NOT depend on the

    1. size.
    2. length.
    3. temperature.
    4. cost.

4. The quantity of electrons flowing in circuit is known as

    1. amperage.
    2. ohms.
    3. resistance.
    4. watts.

5. Battery capacity is determined by the

    1. amount of electrolyte present.
    2. size of the battery case.
    3. amount of lead in the negative plate.
    4. plate area.

6. If the starter cranks the engine but the engine will NOT start, the trouble may be in the

    1. starting system.
    2. battery.
    3. charging system.
    4. starter switch.

7. If the starter relay does NOT click when the ignition key is turned to "start" the problem may be in the

    1. transmission.
    2. ignition system.
    3. battery.
    4. fuel system.

8. If the starter drive engages the flywheel, but the engine FAILS to turn, it may be due to

    1. a defective battery.
    2. the distributor adjustment.
    3. a locked fuel pump.
    4. incorrect timing.

9. If the starter drive is stuck, it may be released by

    1. pushing the vehicle at 45 M.P.H.
    2. cranking the engine with the starter.
    3. rocking the vehicle.
    4. drifting the vehicle backward in neutral.

10. If the starter spins but will NOT crank the engine, the bendix may be

    1. too hot.
    2. undersized.
    3. dirty.
    4. out of adjustment.

11. Which of the following is NOT a cause for slow engine cranking?

    1. Excessive circuit resistance
    2. Discharged battery
    3. Sulphated battery
    4. Fully-charged battery

12. In checking a starting system, first determine whether the

    1. engine is running properly.
    2. generator or alternator has the correct pulley.
    3. starter is turning properly.
    4. battery is in good condition.

13. Which of the following is NOT a battery test?

    1. Capacity test
    2. State-of-charge test
    3. Circuit resistance test
    4. Voltage test

14. The maximum allowable resistance in a battery ground cable is

    1. 0.1 of a volt.
    2. 0.3 of a volt.
    3. 0.5 of a volt.
    4. 0.7 of a volt.

15. The maximum allowable resistance between the battery and starting motor is

    1. 0.1 of a volt.
    2. 0.3 of a volt.
    3. 0.5 of a volt.
    4. 0.7 of a volt.

16. The maximum allowable resistance in the battery circuit through the relay switch is

    1. 0.1 of a volt.
    2. 0.3 of a volt.
    3. 0.5 of a volt.
    4. 0.7 of a volt.

17. A starter should be cleaned using a

    1. steel wire brush.
    2. brass wire brush.
    3. soft bristle brush.
    4. fine wire brush.

18. When removing a defective starter, it is necessary to first

    1. lift the vehicle with a hoist.
    2. instruct others not to attempt to start the vehicle.
    3. disconnect the battery.
    4. clean the area around the starter.
    5. remove the keys from the ignition switch.

19. Current drain (full-load) tests can be made safely with

    1. all starters.
    2. only folo-thru starters.
    3. only hard crank starters.
    4. only positive-engagement starters.

20. If the starting circuit operates properly when the neutral switch is operated by hand, the trouble may be corrected by

    1. replacing the starter solenoid.
    2. adjusting the starter switch.
    3. adjusting the neutral switch.
    4. adding water to the battery.

21. The starter solenoid switch can be checked by connecting a heavy jumper wire from the

    1. relay battery terminal to the relay starter terminal.
    2. relay battery terminal to the neutral switch.
    3. relay battery terminal to the ignition switch.

22. The growler checks the armature for

    1. short circuits.
    2. grounds.
    3. open circuits.
    4. parallel circuits.

23. To prevent the engine from starting when starter tests are made, remove the

    1. ignition coil high tension lead from the distributor.
    2. spark plug boot.
    3. battery ground cable.
    4. air cleaner element.

24. A starter solenoid is used to carry high amperage current from the battery to the

    1. ignition switch.
    2. generator.
    3. headlight switch.
    4. starter.

25. The neutral switch can be tested by connecting a jumper wire between the

    1. battery and the starter relay.
    2. neutral switch lead wire terminals.
    3. ignition coil and the regulator.
    4. battery and the generator.

26. To neutralize spilled battery electrolyte, use

    1. distilled water.
    2. baking powder.
    3. baking soda.
    4. sulfuric acid.

27. The specific gravity of a battery's electrolyte goes up with

    1. an increased state of charge.
    2. a higher temperature.
    3. a higher discharge rate.
    4. a decrease in the regulator's field strength.

28. If a battery requires a considerable amount of water in all cells, it is possible that it

    1. has a cracked case.
    2. is in a sulfated condition.
    3. is being overcharged.

29. The typical battery in today's cars is of the

    1. lead-acid type.
    2. carbon-zinc type.
    3. alkaline type.
    4. silver-cobalt type.

30. A circuit breaker takes the place of the

    1. switch.
    2. fuse.
    3. open circuit.
    4. parallel circuit.

31. By doubling the number of turns of wire of a transformer primary coil, what is the amount of voltage that will appear across the secondary coil?

    1. One-half
    2. The same
    3. Twice

32. Ohm's law states that the resistance of a circuit can be calculated by

    1. voltage divided by amperes.
    2. amperes times the voltage.
    3. amperes divided by the voltage.

33. The hydrometer measures the

    1. voltage available.
    2. specific gravity.
    3. resistance (in ohms).
    4. amperes of pressure.

34. Dry cells, regardless of size, furnish

    1. amperes.
    2. volts.
    3. ohms.

35. A circuit in which all of the electrical energy must pass through ALL of the electrical devices is called

    1. a series circuit.
    2. a parallel circuit.
    3. an open circuit.

36. Batteries are frequently connected in series to increase the

    1. amperage.
    2. voltage.
    3. flux.

37. An electromagnet containing a soft-iron core is called

    1. a relay.
    2. an armature.
    3. a solenoid.

38. A circuit can be

    1. open.
    2. shorted.
    3. corroded.
    4 All of the above

39. The material MOST commonly used as a coated conductor in the automobile is

    1. lead.
    2. steel.
    3. copper.
    4. tin.

Unit: THE CHARGING SYSTEM

Outline of Unit

I. Introduction

II. Battery

III. Alternator

IV. Current Regulators

V. Drive Belts

VI. Current Indicators

VII. Cables and Wiring Harness

Goal Statement

The automotive mechanic successfully trouble shoots, makes component repair or replacement decisions concerning the charging system as encountered in the service setting and follows this with corrective action. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manuals. He also must be able to communicate effectively with other service personnel.

General and Specific Objectives

I. The student will understand the importance of a properly functioning charging system and its relationship to other automotive components. Specifically the student will be able to:

   A. describe the results of a malfunctioning charging system.
   B. list the automotive components dependent upon the charging system.
   C. given the time spent and the income derived from charging system service and other automotive unit service, compare them.

II. The student will understand the nomenclature related to the charging system. Specifically the student will be able to:

   A. given a list of technical terms, identify those pertaining to the charging system.
   B. describe how to test and repair a charging system using technical terms.
   C. given a list of technical terms, match them with the correct definitions.
   D. given a diagram of the charging system, correctly label the component parts using technical terms.

III. The student will comprehend the construction, operation and function of the components of the charging system. Specifically the student will be able to:

- A. identify the components parts of the storage battery.
- B. given a storage battery, perform capacity and state-of-charge tests.
- C. explain the storage battery's operation.
- D. given an alternator diagram, correctly show current flow and label the parts.
- E. given an alternator, disassemble and test the stator, rotor, and diodes for open or shorted circuits.
- F. given a current regulator diagram, correctly label the parts and show current flow.
- G. explain how a current regulator operates.
- H. given a charging system diagram, correctly trace the charging indicator circuit.
- I. explain the results of improper drive belt tension.
- J. demonstrate proper adjustment of the drive belts.
- K. given a list of charging system malfunctions, state the probable causes and corresponding corrective measures.

IV. The student will know how to safely perform the required trouble shooting and repair procedures related to the charging system. Specifically the student will be able to:

- A. given a list of shop procedures, identify those which are safe.
- B. demonstrate the correct use of all applicable test equipment.
- C. given a vehicle and pertinent testing equipment, perform all tests, observing safety precautions.

V. The student will know how to effectively communicate diagnostic results, parts procurement, and procedural steps necessary for proper repair of the charging system. Specifically the student will be able to:

- A. complete diagnostic forms correctly.
- B. list the necessary repair parts clearly.
- C. explain the necessary procedural steps for component repair.
- D. discuss the charging system's malfunctions with the owner.

VI. The student will understand how to repair or service as necessary, the components of the charging system. Specifically the student will be able to:

- A. clean the battery terminals and cover.
- B. test/replace battery cables.
- C. given a specific vehicle, remove, analyze and replace the alternator.
- D. given a specific automobile, perform current regulator adjustments.
- E. given a specific automobile, perform alternator output tests.
- F. select the proper special tools for alternator and regulator service and repair.

VII. The student will understand how to perform the necessary tasks, adjustments and repairs to the charging system with both speed and accuracy so as to meet or exceed job entry requirements. Specifically the student will be able to:

A. look up time/rate schedules for charging system repairs.
B. given a repair order and labor rate, compute the labor charges using a flat rate manual.
C. explain the effects of customer "comebacks" on future business.

TEST

1. Which of the following failures would NOT generally be due to a faulty charging system?

    1. Dim headlamps
    2. Low battery specific gravity
    3. Charge indicator light on
    4. Burned ignition points
    5. Slowed signal light operation

2. Which of the following components does NOT depend upon the charging system for successful operation?

    1. The starting system
    2. The ignition primary system
    3. The lighting system
    4. The ignition secondary system

3. Which of the following terms does NOT pertain to the charging system?

    1. Diode
    2. Sulfation
    3. Temperature compensation
    4. Stator
    5. Resistor

4. The term that BEST describes the charging system capacity is

    1. amp/hour rating.
    2. high rate discharge capacity.
    3. current output rating.
    4. relay cut-in voltage.

5. Which of the following is the SAFEST approach to performing a charging system output test?

    1. Calibrate volt-amp meter
    2. Disconnect battery cables
    3. Ground the alternator output terminal
    4. Connect the jumper lead from the "f" terminal to the ground

6. Which one of the following steps is NOT necessary when performing current regulator adjustments?

    1. Bringing the system to the operating temperature
    2. Performing a battery variable load test
    3. Adjusting the drive belt tension
    4. Performing a rotor core test

7. The voltage of a lead acid cell is 2.1 volts. This is controlled by the

    1. electrolyte level.
    2. thickness of the lead plates.
    3. cell size.
    4. sulfuric acid and lead components.

8. If during the light-load test, all cells read 1.95 volts or above and there is no more than 0.5 volts difference, the battery

    1. is in good condition but needs charging.
    2. should be cycled and rechecked.
    3. is in full-charge condition.
    4. must be replaced.

9. In the current limiter test, when a carbon pile rheostat is included in the circuit,

    1. a field rheostat must also be connected.
    2. the regulator must be removed to the test bench to control the alternator speed precisely.
    3. the load must not be increased too rapidly.
    4. 1.5 ohm resistance must be used in place of the battery.

10. IMPROPER drive belt tension may cause

    1. alternator bearing failure.
    2. high state-of-charge in the battery.
    3. pulsation of the three-phase current.
    4. a shortened voltage regulator life.

11. If the labor rate is $7.50/hour and the flat rate time is 1.2 hours, then the correct labor charge is

    1. $8.75
    2. $9.00
    3. $9.50
    4. $10.00

12. A test reading of 2.5 volts below specifications for alternator output indicates

    1. an open stator.
    2. grounded brushes.
    3. a shorted rotor.
    4. a shorted diode.

13. The unit that rectifies AC current is the

    1. stator.
    2. diode.
    3. field terminal.
    4. rotor.

14. A discharged battery accompanied by a high charging rate indicates

    1. the battery is defective.
    2. the system is okay.
    3. low alternator output.
    4. the regulator needs adjustment.

15. The sustance USUALLY used to clean battery terminals and cover is

    1. kerosene.
    2. parts solvent.
    3. baking soda.

16. The FIRST step in replacing an alternator is to

    1. disconnect the battery cables.
    2. loosen the drive belt.
    3. remove the mounting bolts.
    4. remove the wires from the terminals.

17. The major ADVANTAGE of the transistorized regulator is that it

    1. permits a higher field current.
    2. permits a lower field current.
    3. eliminates the cutout relay.
    4. makes all transistors simple to replace.

18. A precaution to observe when servicing diodes is to

    1. avoid overheating the diode when soldering.
    2. replace the end frame if the diodes are defective.
    3. tap the diode lightly with a hammer to seat securely.
    4. always have an electronics technician do the work.

19. When checking the system, a discharged battery accompanied by a low charging rate indicates

    1. the battery is defective.
    2. the system is okay.
    3. the regulator should be adjusted.
    4. further checks should be made.

20. A charged battery accompanied by a low charging rate means

    1. the system is okay.
    2. the battery is defective.
    3. the regulator requires adjustment.
    4. the alternator output is low.

21. Drive bolts are of the "V" design and therefore they

    1. are easier to install.
    2. are more economical.
    3. resist stretching.
    4. have a self-tightening effect.

22. The purpose of the fan located behind the drive pulley of an alternator is to

    1. circulate the air in the engine's compartment.
    2. cool the fan belt and extend its life.
    3. blow air through the alternator.
    4. draw hot air out of the alternator.

23. An alternator is the most practical electrical power source for the automobile because it

    1. does not require extensive repairs.
    2. produces a usuable amount of current at high speeds.
    3. can be used with a regulator.
    4. produces a usuable amount of current at low speeds.

24. The FIRST step in diagnosing a charging system problem is to

    1. test the battery.
    2. verify the customer's complaint.
    3. perform a visual inspection.
    4. start and run the engine.

25. What may have to be done, as a last resort, to correct a regulator ground problem?

    1. Replace the regulator
    2. Run a wire from regulator frame to alternator frame
    3. Run a wire from regulator frame to battery ground post
    4. Attach ground strap from regulator frame to car frame

26. When the charging system and battery test in accordance with specifications, but the battery will not stay charged over a period of time, it may be necessary to

    1. install a larger battery.
    2. install a larger output alternator.
    3. increase the voltage regulator settings.
    4. perform an electric load check-out.

27. A loose connection in the charging circuit causes an undesirable

    1. voltage drop.
    2. high current flow.
    3. resistance drop.
    4. lowered resistance.

28. The ammeter is connected between the battery and the

    1. alternator field terminal.
    2. regulator field relay.
    3. battery terminal of the alternator.
    4. None of the above

29. To read a wiring diagram, follow a wire by

    1. color and letter.
    2. number and letter.
    3. number and color.
    4. None of the above

30. Use an insulated tool to adjust the regulator to

    1. prevent high voltage.
    2. avoid cycling the battery.
    3. prevent damage to the tool.
    4. avoid getting shocked.

31. Silicon diodes are checked by using a(n)

    1. ammeter.
    2. voltmeter.
    3. oscilloscope.
    4. ohmmeter.

32. What is the CORRECT way to polarize an alternator?

    1. Ground field lead to case
    2. Connect jumper between output and field
    3. Connect jumper from battery to field terminal
    4. An alternator does not need polarization.

33. Which is the LEAST accurate statement regarding alternator precautions?

    1. Polarity must be observed at all times.
    2. Connect a booster battery in parallel with installed battery
    3. Never operate the alternator more than 30 seconds with output terminal disconnected
    4. Never by-pass the field circuit

34. Diodes are needed to

    1. control the alternator output.
    2. rectify the alternating current from the alternator.
    3. rectify the direct current from the alternator.
    4. protect the alternator from overcharging.

35. As a rule, if the stator winding is open, shorted, or grounded, the proper procedure is to

    1. repair the winding.
    2. replace the rotor.
    3. rewrap the winding.
    4. replace the winding.

36. When operating, the voltage regulator prevents excessive voltage by inserting resistance into the

    1. stator circuit.
    2. battery circuit.
    3. relay circuit.
    4. field circuit.

37. A loose alternator drive belt may cause

    1. low alternator output.
    2. front bearing failure.
    3. improper regulator action.
    4. a burn-out of the fusible link.

38. Installing a battery backwards may burn out the alternator

    1. stator.
    2. rotor.
    3. diodes.
    4. commutator.

39. When using a test light to check a diode, the light should go on

    1. in one direction only.
    2. in neither direction.
    3. in both directions.

40. In the fully transistorized regulator, field current is controlled by the

    1. diodes.
    2. transistors.
    3. contact points.
    4. rectifiers.

41. The FIRST step in checking the specific gravity of a battery is to

    1. disconnect the cables.
    2. charge the battery.
    3. add water.
    4. remove the vent plugs.

Unit: DIAGNOSIS AND TUNE-UP

Outline of Unit

I. Diagnostic Principles and Methods

II. Operation of Diagnostic Equipment

III. Emission Controls

IV. Minor Tune-up

V. Major Tune-up

Goal Statement

The automotive mechanic successfully trouble shoots, makes component repair or replacement decisions concerning tune-up procedures as encountered in the service setting and follows this with corrective action. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manuals. He also must be able to communicate effectively with other service personnel.

General and Specific Objectives

I. The student will understand how to evaluate basic engine conditions. Specifically the student will be able to:

   A. list visible malfunctions by an underhood inspection.
   B. perform compression and leakage tests on cylinders.
   C. interpret compression and cylinder leakage test results.
   D. tighten the cylinder head and intake manifold bolts using a torque wrench.
   E. given specific problems, discuss the complaints with the vehicles's owner.

II. The student will understand how an ignition system operates. Specifically the student will be able to:

   A. identify the primary circuit.
   B. state the function of the coil.
   C. explain the purpose of the condenser.
   D. describe the functions of the distributor assembly.
   E. state the purpose of the spark plugs.
   F. explain the purpose of the ignition switch.
   G. given an eight cylinder engine, explain the dwell angle.

III. The student will understand how the fuel system operates. Specifically the student will be able to:

A. explain fuel pump testing procedures.
B. list the six carburetor circuits.
C. list the four main components of the fuel supply system.
D. given various service manuals, locate the carburetor specifications.
E. state the proper method for cleaning an air cleaner element.
F. describe the proper method for cleaning carburetor parts.

IV. The student will understand how the emission controls operate. Specifically the student will be able to:

A. list the four sources of engine emissions.
B. state the function of a positive crankcase ventilation system.
C. explain the basic function of the exhaust emission control devices.
D. identify the various types of emission control systems.
E. given the various gases produced by the automobile engine, explain their effect on humans.

V. The student will understand how to repair or replace the various tune-up components. Specifically the student will be able to:

A. clean fuel filters.
B. make carburetor adjustments.
C. install ignition points.
D. set dwell and timing.
E. install the distributor properly for correct timing.
F. install a condenser.
G. replace a distributor cap and rotor.
H. replace the resistor.
I. replace the PCV valve.
J. service the oil breather cap.

VI. The student will understand how to locate problems by using the diagnostic equipment and service data available. Specifically the student will be able to:

A. use the proper gauge for checking fuel pump pressure.
B. determine the air-fuel mixture by using the combustion analyzer.
C. locate the dwell pattern on the scope and adjust it properly.
D. identify the various patterns of the primary circuit.
E. recognize defective spark plug wires on a scope screen.
F. determine the condition of the spark plug wires through use of an ohmmeter.

VII. The student will understand the importance of safety practices while performing all service operations. Specifically the student will be able to:

A. ground the secondary ignition system.
B. explain how to prevent gasoline fires during carburetor service procedures.

C. determine that testing equipment leads are clear of fan and belts.
D. determine that the vehicle is out of gear when "bumping" the starter.
E. hook booster cables properly when starting another vehicle.

VIII. The student will understand the functions of the starting and charging systems. Specifically the student will be able to:

A. identify the positive and negative posts of the battery.
B. given a component part, relate it to the system to be checked.
C. hook the meters properly when checking a circuit.
D. perform a starter check-out test.
E. perform a specific gravity test.

TEST

1. In making a visual underhood inspection of an automobile that is misfiring, which of the following malfunctions would NOT be obvious?

   1. Disconnected plug wires
   2. Blow-by from the oil breather cap
   3. A cracked distributor cap
   4. Insulation off primary wires
   5. A broken ground electrode on the spark plug

2. A compression and leakage test is performed on an engine to detect

   1. defective rings.
   2. worn cam bearings.
   3. a leaking valve gasket.
   4. improper timing.
   5. leaking exhaust manifold.

3. Which of the following BEST describes leaking rings as indicated on on a vacuum gauge?

   1. Low and steady needle
   2. Rapid vibration of needle
   3. Floating motion of needle
   4. Needle remains steady and normal
   5. Needle is normal when first started, then drops to zero and rises to below normal slowly

4. When torquing the cylinder head or intake manifold bolts, you would

   1. begin on the shorter bolts and work to the longer ones.
   2. torque in any manner, just as long as they are all torqued to the manufacturer's specifications.
   3. begin in the center and work outward, torquing to the manufacturer's specifications.
   4. begin at either end and torque each bolt to the manufacturer's specifications then go to the next bolt.

5. The primary circuit of the ignition consists of the

   1. small insulated wiring running to the coil, distributor and resistor.
   2. larger wiring running from the coil and from the distributor to the plugs.
   3. wire from the center of the coil to the center of the distributor.
   4. positive cable from the battery to the solenoid.

6. Which of the following builds the high tension voltage necessary to fire at the plug gap?

   1. Battery
   2. Points
   3. Condenser
   4. Coil
   5. Centrifugal advance

7. The purpose of the ignition condenser is to

   1. give a hotter spark at the points.
   2. open and close the primary circuit.
   3. reduce arcing at the breaker points
   4. connect and disconnect the ignition system from the battery.

8. The distributor has three functions. Two of these are to make and break the primary circuit and to distribute high tension voltage to each cylinder. The third is to

   1. advance or retard timing.
   2. make it possible to start or stop the engine as desired.
   3. reduce the voltage from 12 volts to 6 volts.
   4. store the voltage for high RPM
   5. assure correct polarity in the ignition system.

9. Which of the following provides the final air gap to fire the combustible mixture in the cylinder?

   1. Breaker points
   2. Rotor
   3. Resistor
   4. Spark plug
   5. Condenser

10. Which of the following connects and disconnects the battery from the primary circuit?

    1. Ignition coil
    2. Voltage reducer
    3. Rotor button
    4. Ignition switch

11. On a typical eight cylinder engine with a dwell setting of 30 degrees, how many degrees of distributor shaft rotation would the points remain open per cylinder?

    1. 15
    2. 26-31
    3. 45
    4. 180
    5. None of the above

12. Which of the following applies to fuel pump testing?

    1. Compression
    2. Pressure
    3. Valve
    4. Diaphragm

13. Which of the following is NOT a carburetor circuit?

    1. Float circuit
    2. Vacuum kick-back circuit
    3. Choke circuit
    4. Idle and low speed circuit
    5. High speed, part-load circuit

14. Which of the following is NOT a part of the fuel supply system?

    1. Fuel pump
    2. Fuel tank
    3. Fuel gauge
    4. Carburetor
    5. Intake manifold

15. Which of the following would be an ideal air-fuel ratio for normal engine cruising operation?

    1. 8 to 1
    2. 12 to 1
    3. 15 to 1
    4. 19 to 1

16. How should a paper air filter element be cleaned?

    1. By washing it in a cleaning solvent
    2. By blowing it out with compressed air
    3. By washing it in gasoline
    4. By using a vacuum cleaner
    5. By tapping it against some hard surface

17. If you have disassembled a carburetor and are preparing to soak the parts in a carburetor cleaner solution, you would NOT soak the

    1. pump diaphragm.
    2. needle valve.
    3. jets.
    4. throttle plate.

18. Which of the following is NOT an emission producing area?

    1. Engine crankcase
    2. Exhaust
    3. Carburetor
    4. Gasoline tank
    5. Cooling system

19. The positive crankcase ventilation system removes all pollutants from engine oil EXCEPT which of the following?

    1. Water vapor
    2. Blow-by gases
    3. Acid
    4. Gasoline vapor
    5. Oil fumes

20. Which of the following functions BEST describes the exhaust emission control?

    1. It forces air to the exhaust parts.
    2. It pumps fresh air through the air cleaner.
    3. It pumps unburned gases back to the tank.
    4. It reduces heat in the exhaust manifold.

21. Which of the following emission systems is related to GM products?

    1. C.A.P. system
    2. I.M.C.O. system
    3. A.I.R. system

22. Which of the following exhaust gases is NOT deadly, but causes the eyes to smart?

    1. Carbon dioxide and water
    2. Carbon monoxide
    3. Hydrocarbons
    4. Nitrogen oxides

23. When servicing fuel filters, which one of the following types can be cleaned?

    1. Fine screen
    2. Ceramic
    3. Treated paper
    4. Sintered bronze

24. To make a carburetor adjustment for a fuel level that is too high, adjust the

    1. float.
    2. fuel intake valve.
    3. discharge nozzle.
    4. fuel pump pressure valve.

25. When gauging points, the rubbing block of the points should be located

    1. on the high point of the cam.
    2. on the breaker plate.
    3. at the base of the distributor.
    4. in line with the rotor button.

26. When setting dwell on an engine and dwell must be increased, which of the following statements is CORRECT?

    1. Open the points slightly
    2. Disconnect the vacuum line
    3. Turn the adjusting screw counterclockwise
    4. Lock out the centrifugal advance
    5. Close the points slightly

27. To install a distributor assembly properly in an engine for correct timing, which of the following statements is CORRECT?

    1. Check the firing order and point the rotor toward the number one plug wire
    2. Hook the timing light to the number one plug wire and set timing properly on the power stroke
    3. Position the number one piston at top center (compression stroke) with timing mark on TDC and point the rotor toward the number one plug position on the distributor cap
    4. Set the distributor correctly, using the distributor machine, and install with the rotor pointed toward the number one plug wire
    5. Check the valves on number one cylinder and install the distributor with the rotor pointed toward the number one plug wire with the intake valve open.

28. If an engine will start, but fails to continue running when the key is released, which of the following may be defective?

    1. Ignition by-pass wire
    2. Ignition coil
    3. Ballast resistor
    4. Primary wire
    5. Secondary coil wire

29. Which of the following locations for replacing PCV valve is correct?

    1. In the inlet pipe
    2. Under the valve covers
    3. Between the intake manifold and the crankcase emission outlet
    4. Between the carburetor and the oil filler cap

30. Which of the following is used when cleaning an oil filler/breather cap?

    1. Gas
    2. Oil
    3. Water
    4. Soap
    5. Varsol

31. To check a fuel pump which is not supplying the proper amount of gas to the carburetor, which of the following gauges should be used?

    1. Feeler gauge
    2. Pressure gauge
    3. Compression gauge
    4. Plastigage
    5. Dial gauge

32. If the combustion analyser reads 14 to 1, which of the following is being checked?

    1. Compression ratio
    2. Piston displacement
    3. Air-fuel mixture
    4. Cylinder volume

33. Cam angle or dwell means

    1. the number of degrees of distributor cam rotation during the time the points are open.
    2. the angle at which the rubbing block contacts the cam.
    3. the number of degrees the crankshaft rotates from the time the points open until they close.
    4. the distance between the lobes of the cam.
    5. the number of degrees the distributor shaft cam rotates while the points are closed.

34. Which one of the following components CANNOT be checked by using the primary pattern on the scope?

1. Points
2. Plug wires
3. Condenser
4. Resistor

35. Which of the following BEST describes the pattern on the oscilloscope screen for a defective plug wire?

1. One spike higher than the others
2. One spike does not show on the screen
3. One spike has an arc at a 90° angle
4. One spike fades out when the plug wire is removed
5. One spike shows up as red or orange

36. Which of the following is used to check the condition of individual plug wires?

1. Voltmeter
2. Ammeter
3. Ohmmeter
4. Tachometer

37. To prevent the engine from starting when cranking for a fuel pump test, it is necessary to remove and ground the

1. high tension coil wire.
2. spark plug wires.
3. battery ground cable.
4. ignition switch lead.
5. number one plug wire.

38. Which of the following would be the MOST important reason for immediately cleaning up gasoline that is spilled on the engine or floor when making a fuel pump test?

1. Shop neatness
2. Fall prevention
3. Engine harm and floor paint damage
4. Fire prevention

39. Which of the following would be a safe way to operate the oscilloscope?

1. Use a fender cover when working under the hood
2. Use jack stands to hold rear wheels off the floor
3. Hook the oscilloscope to the proper connection
4. Route the leads so they are free of the fan and belts

40. When working on the electrical system, which of the following rules should be observed?

    1. Gloves should be worn.
    2. The floor should be dry and insulated.
    3. All power should be cut off.
    4. Rings should not be worn.

41. If the battery booster cables are NOT properly hooked on a car equipped with an alternator, which of the following would be damaged?

    1. Stator
    2. Rotor
    3. Field terminal
    4. Diodes

42. One type of fuel evaporation control systems used on late model cars is the

    1. non-vented fuel tank cap.
    2. vented fuel tank cap.
    3. hydrocarbon tank cap.
    4. All of the above

43. Two types of positive crankcase ventilation systems are the closed type and the

    1. air flow cleaner type.
    2. air injector type.
    3. backfiring type.
    4. open type.

44. A typical air injector system is

    1. the thermactor.
    2. the ventilation.
    3. the pressurized.
    4. the rotor.

45. When connecting an ammeter in a circuit, it would be connected in which of the following manners?

    1. Parallel
    2. Across
    3. Series
    4. All of the above

46. Which of the following is NOT a part of the starting, charging or ignition systems?

    1. Sending unit
    2. Battery
    3. Coil
    4. Regulator

47. The rotor, stator and end frame assemblies are component parts of

    1. an electronic control unit.
    2. a regulator.
    3. a rectifier.
    4. an alternator.

48. The negative post of a battery can be identified because

    1. it is the larger post.
    2. it is painted red.
    3. it has a + sign stamped on the post.
    4. it is the smaller post.

49. Which of the following electrical circuits would NOT normally be checked in an engine tune-up?

    1. Starting circuit
    2. Charging circuit
    3. Ignition circuit
    4. Lighting circuit

50. Hydrocarbon emissions result from

    1. lean mixture.
    2. high combustion temperature.
    3. engine misfiring.
    4. gasoline additives.

51. When are evaporation emissions the most serious problem?

    1. When the vehicle is hot and running at high speeds
    2. When the engine is cut off with a hot soak situation involved
    3. During sudden acceleration
    4. When high octane fuel is used

52. Which of the following would NOT be a cause for engine dieseling after the engine is turned off?

    1. Idle speed too high
    2. Solenoid stuck in up position
    3. Low octane fuel
    4. Diverter valve stuck closed

53. Which of the following usually accompanies photochemical smog?

    1. Lung damage
    2. Eye irritation
    3. Severe headache
    4. Skin rash

54. What is the major reason for REDUCING the lead content of gasoline?

    1. To reduce hydrocarbon emission
    2. To lower the fuel cost
    3. To prevent catalyst contamination
    4. To minimize engine deposits

55. The primary reason for adding preheated air to an engine exhaust manifold is to

    1. improve engine starting.
    2. minimize carburetor icing.
    3. reduce harmful emissions.
    4. prevent engine freezing at very low temperatures.

56. Lean air/fuel mixtures are difficult to ignite. They can be made to ignite easier by increasing the

    1. engine speed.
    2. compression ratios.
    3. charge temperature.
    4. volumetric efficiency.

57. Excessive resistance in a cranking motor circuit can result from

    1. corroded battery terminals.
    2. an undersized battery.
    3. a discharged battery.

58. Cranking time in excess of 30 seconds can cause the

    1. battery to overheat.
    2. cranking motor to overheat.
    3. switch contacts to overheat.

59. In some instances, the starter solenoid has an additional function to perform. It is to

    1. close the choke on the carburetor.
    2. by-pass the ignition resistor.
    3. close the regulator cut-out relay.

60. Distributor shaft cams should be lubricated with high temperature grease to

    1. prevent distributor shaft wear.
    2. reduce friction at the advance weights.
    3. prevent wear of the contact arm rubbing block.

61. It is important that the ignition coil be correctly connected in the primary circuit. The distributor primary lead should be connected to the coil primary

    1. marked positive (+).
    2. marked negative (-).
    3. the same as the battery polarity.

62. Increasing the point opening will

    1. advance the timing.
    2. retard the timing.
    3. not change the timing.

63. If the distributor vacuum line is connected directly to the intake manifold, at idle the ignition timing will be

    1. fully retarded.
    2. advanced halfway.
    3. fully advanced.

64. If the engine turns over normally but does not start, the trouble would probably be in the

    1. battery.
    2. regulator.
    3. ignition or fuel.
    4. starter drive mechanism.

65. A battery with a specific gravity of 1.290 can be considered

    1. discharged.
    2. half-charged.
    3. fully-charged.
    4. shorted out.

66. The device used to make the specific gravity test is called

    1. a thermometer.
    2. a hydrometer.
    3. a voltmeter.
    4. an ammeter.

67. When performing an engine tune-up, one of the first items to check is the

    1. carburetor adjustment.
    2. ignition timing.
    3. engine compression.
    4. battery condition.

68. On cars equipped with a dual vacuum advance, to set the initial timing it is necessary to

    1. remove the manifold vacuum line.
    2. remove the carburetor vacuum line.
    3. remove the manifold vacuum line and the carburetor vacuum line.
    4. check the manual for the proper procedure.

69. The distributor cap and rotor are a part of the

    1. primary circuit.
    2. secondary circuit.
    3. charging circuit.
    4. starting circuit.

70. When installing a condenser, the lead wire should be connected to the

    1. ignition points.
    2. rotor button.
    3. mounting plate.
    4. distributor cam lobe.

Unit: MANUAL TRANSMISSION AND CLUTCH ASSEMBLY

Outline of Unit

I. Introduction

II. Types of Manual Transmissions

III. Clutch Assembly

IV. Service

Goal Statement

The automotive mechanic identifies, trouble shoots and repairs the manual transmissions and clutch assemblies as encountered in the service department. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. He must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manuals and be able to communicate effectively with other personnel.

General and Specific Objectives

I. The student will understand the theory, design features, and terms related to the clutch/manual transmission. Specifically the student will be able to:

   A. identify each component of the manual transmission and clutch assembly.
   B. distinguish between an open and a closed case transmission.
   C. describe (trace) the power flow from flywheel to propeller shaft
   D. given an article or picture, identify the various manual clutch assembly designs.
   E. explain mechanical advantages, torque multiplication and gear ratio as they pertain to the manual transmission.

II. The student will understand the importance of safe working practices while performing tests and repairs. Specifically the student will be able to:

   A. state what is proper shop clothing for servicing transmission and clutch assemblies.
   B. explain how to use jacks and safety stands properly and safely.
   C. describe how to clean each part in a safe and nondestructive manner.
   D. state the safety precautions to follow while using special tools and equipment.

III. The student will recognize the problems related to each component in the clutch/transmission systems. Specifically the student will be able to:

A. state causes of normal and abnormal wear in the clutch assembly
B. state three causes of clutch chatter.
C. explain the reason for an oil soaked clutch assembly.
D. explain the reason for broken springs in the clutch disc.
E. explain how to make correct clutch linkage adjustments.
F. describe how to remove and install a pilot bushing.
G. describe how to remove and install a clutch release bearing assembly.
H. describe proper transmission lubrication.
I. explain probably causes for difficulty in shifting of gears.
J. list probably causes for gear failure.

IV. The student will understand the importance of knowing how to interpret tests performed on the system. Specifically the student will be able to:

A. explain the meaning and use of a trouble shooting chart.
B. describe the stall test for clutch slippage.
C. explain how to adjust free travel of the clutch pedal.
D. state the probably causes of noise in different gear ranges.
E. explain what causes "jumping out of gear" problems.

V. The student will understand the importance of proficiency in performing the job at a rate equal to the time set by industrial standards. Specifically the student will be able to:

A. given a standard three-speed transmission, completely disassemble and reassemble in flat rate time.
B. given a four-speed transmission, completely disassemble and reassemble in flat rate time.
C. given a specific vehicle, remove old clutch assembly, pilot bushing and release bearing assembly, inspect all components and install new replacement components in flat rate time.

TEST

1. A clutch mechanism is used to

    1. raise or lower the vehicle.
    2. control the wheel spin in mud.
    3. connect and disconnect the engine to the transmission.
    4. connect and disconnect the transmission to the drive line.

2. A clutch mechanism may be operated by all EXCEPT which of the following?

    1. Manual linkage
    2. Human power
    3. Hydraulic pressure
    4. Engine power

3. The pressure plate applies pressure on the

    1. pilot bushing.
    2. clutch disc.
    3. flywheel.
    4. release bearing.

4. The clutch disc lining is made of

    1. aluminum.
    2. nylon.
    3. an asbestos composition.
    4. rayon.

5. The clutch disc lining is secured to the disc with

    1. epoxy glue.
    2. clips.
    3. bolts.
    4. rivets.

6. Force is exerted on the pressure plate by

    1. air pressure.
    2. spring pressure.
    3. hydraulic pressure.
    4. All of the above

7. Release bearings are of the

    1. graphite and ball bearing type.
    2. graphite and roller bearing type.
    3. ball bearing and roller bearing type.
    4. needle and ball type.

8. Manual transmissions fall into which of the following design classes?

    1. Closed case and square case
    2. Open case and square case
    3. Closed case and open case
    4. Open case and round case

9. Which gear tooth design will operate with the LEAST noise?

    1. Spur
    2. Helical
    3. Bevel
    4. Worm

10. A clutch which is noisy when the pedal is depressed and the engine is running indicates

    1. a worn pilot bearing.
    2. insufficient pedal free-travel.
    3. a faulty release bearing.
    4. None of the above

11. When installing a clutch disc, which side contacts the flywheel?

    1. The side with longest part of the hub extension
    2. The side with the short section of hub extension
    3. Either side
    4. The side according to the manufacturer's specifications

12. Clutch cover fasteners should be released

    1. alternately.
    2. individually a few turns at a time.
    3. all at one time.
    4. one at a time.

13. Free-travel in the clutch pedal should be about

    1. 1 inch.
    2. 1 7/8 inches.
    3. 2 inches.
    4. 2 1/4 inches.

14. Before removing the clutch assembly, disconnect the

    1. fan belt.
    2. ingition coil.
    3. spark plug wire.
    4. battery ground strap.

15. The manual transmission's gear ratios are determined at the factory according to

    1. tire size.
    2. transmission size.
    3. differential size.
    4. car weight and engine horsepower.

16. Before removing the transmission, it is necessary to

    1. remove the negative battery terminal.
    2. lift the vehicle and set the safety stands in position.
    3. drain the transmission.
    4. All of the above

17. When the transmission is being removed or installed, it would NOT be allowed to rest on the

    1. output shaft.
    2. input shaft.
    3. motor mount.
    4. cross member.

18. Before disassembling a transmission, it is necessary to

    1. remove the drive shaft.
    2. clean the exterior of the transmission.
    3. clean the drive shaft.
    4. clean the shift mechanism.

19. Which of the following transmission components are used in the high gear position?

    1. Clutch shaft and cluster
    2. Clutch shaft, counter gear, and output shaft
    3. Clutch shaft and output shaft
    4. Synchronizer and cluster

20. In the high-speed gear position, the power travels through the clutch shaft, clutch gear,

    1. countershaft, countershaft high gear, second and high gear.
    2. countershaft second and high gear, mainshaft.
    3. second and high gear, synchronizer, mainshaft.

21. In the reverse gear position, the power travels through the clutch gear, the counter gear

    1. reverse countershaft gear, reverse idler, low and reverse gear, main shaft.
    2. low and reverse gear, main shaft low and reverse gear.
    3. reverse gear, low and reverse gear.

22. If the transmission sticks in gear, the trouble could be due to

    1. misalignment, a slipping clutch, or a bent shifter fork.
    2. the clutch not releasing or the linkage being out of adjustment.
    3. worn bearings, misalignment, or a bent shifter fork.

23. The most likely cause of clutch slippage is

    1. excessive pressure plate spring tension.
    2. insufficient pressure plate spring tension.
    3. excessive pedal lash.
    4. excessive pedal free-travel.

24. Clutch pedal free-travel is corrected by adjusting the

    1. release levers.
    2. clutch linkage.
    3. release bearing.
    4. pivot ball.

25. If the clutch chatters or grabs when engaging, chances are the trouble is

    1. in the clutch linkage.
    2. in the clutch itself.
    3. due to misalignment of the transmission and engine.
    4. a "nervous" pedal.

26. The friction disc is splined to the

    1. crankshaft.
    2. transmission output shaft.
    3. clutch shaft.
    4. counter shaft.

27. The clutch is positioned between the transmission and the

    1. power train.
    2. engine.
    3. propeller shaft.

28. The throw-out bearing is forced to move by the

    1. pressure on the friction disc.
    2. pivoting of the clutch pedal.
    3. pivoting of the clutch fork.

29. In the coil-spring clutch, when the throw-out bearing is moved inward, it actuates the

    1. pressure plate.
    2. disc.
    3. release levers.
    4. clutch fork.

30. If a 10-tooth gear is meshed with a 25-tooth gear, the gear ratio is

    1. 10:25
    2. 2:5
    3. 1:2.5
    4. 1:.25

31. In gear systems, speed reduction means

    1. torque reduction.
    2. torque increase.
    3. nothing.

32. In first gear, the power travels through the clutch shaft,

    1. drive gear, second gear, first gear, and shaft.
    2. low gear, drive gear, low and reverse gear, and main shaft.
    3. counter gear, low gear, low and reverse gear, and main shaft.

33. Before assembly, the transmission should

    1. be thoroughly cleaned.
    2. be lubricated.
    3. have new gaskets and seals installed.
    4. have all worn parts replaced.
    5. All of the above

34. When assembling a transmission, it is necessary to always check

    1. for leaks.
    2. the end play of all parts.
    3. worn parts.
    4. lubricant level.

35. A gear from a manual transmission should never be re-used if it shows any signs of

    1. chipping.
    2. excessive wear.
    3. galled surfaces.
    4. All of the above

36. Before adjusting the shift linkage, the manual transmission must be placed in

    1. second.
    2. neutral.
    3. reverse.
    4. first.

Unit: AUTOMATIC TRANSMISSION FUNDAMENTALS

Outline of Unit

I. Fluid Coupling and Torque Converter

II. Pumps

III. Clutches

IV. Bands and Servo

V. Gear Assembly

VI. Valve Body and Governor

VII. Automatic Transmission Service

Goal Statement

An automatic transmission specialist efficiently and safely diagnoses common automatic transmission problems. He uses the various types of diagnostic equipment necessary to trouble shoot the hydraulic systems and must be familiar with the various service manuals. He must identify the type of transmission, order the correct parts, make out a repair order, and properly install the component parts.

General and Specific Objectives

I. The student will comprehend basic automatic transmission problems. Specifically the student will be able to:

  A. check the engine to verify that it is sound mechanically and properly tuned.
  B. check fluid for odor, discoloration, aeration, and signs of water.
  C. make a visual check for oil leaks.
  D. given the manufacturer's specifications, conduct a stall test.
  E. given the manufacturer's specifications, check the fluid.

II. The student will understand the operating principles of the fluid coupling and the torque converter. Specifically the student will be able to:

  A. define vortex flow.
  B. explain the purpose of the vanes in the converter.
  C. explain the relationship of the stator to the pump and turbine.
  D. explain the principles of torque multiplication.
  E. identify the component parts of the torque converter.
  F. name the two members that develop torque in the converter.

III. The student will understand the function of the planetary gearset. Specifically the student will be able to:

  A. explain the function of the component parts when the internal gear is held stationary.
  B. describe the action necessary to reverse the power flow.
  C. determine what operation is necessary in the transmission for a change in the planetary gear ratio.
  D. explain what happens in the planetary gear assembly when no increase or decrease of torque is necessary.
  E. identify each part of the planetary gearset.

IV. The student will understand how to make all external adjustments to the automatic transmission. Specifically the student will be able to:

  A. perform a manual shift transmission linkage adjustment.
  B. check engine mounts before adjusting any linkages.
  C. given the manufacturer's specifications, adjust the anti-stall dashpot which controls throttle return.
  D. adjust the neutral safety switch for proper functioning.
  E. given the manufacturer's specifications, explain external band adjustments.

V. The student will understand the hydraulic system and its related parts. Specifically the student will be able to:

  A. explain the action necessary to shift the manual control valve.
  B. explain where hydraulic pressure is applied for low range operation.
  C. given all the parts of the main control valve body, identify and indicate the function of each.
  D. diagnose the malfunctioning of a hydraulic component by using air pressure through the correct pressure passages.
  E. explain the purpose of the pressure regulator valve.
  F. explain the purpose of the front pump.

VI. The student will understand the function of each internal component of the automatic transmission. Specifically the student will be able to:

  A. disassemble the front pump and name its component parts.
  B. explain the purpose of bands and their respective action.
  C. explain the purpose of servos in the automatic transmission.
  D. remove an extension housing assembly and demonstrate the operation of the governor assembly.
  E. dismantle a complete clutch drum assembly and explain the function of each component part.
  F. state the purpose of the rear pump.

VII. The student will understand how to perform complete periodic maintenance service of the automatic transmission. Specifically the student will be able to:

A. explain how shift points can be influenced.
B. given a specified engine RPM use the correct diagnostic equipment to check fluid pressure and vacuum.
C. given various transmission types, identify them and install correct service parts.
D. given the manufacturer's specifications, check external and internal band adjustments.
E. remove the modulator valve vacuum hose and check for fluid leak through the diaphragm.
F. use the proper methods for cleaning and installing parts.

VIII. The student will understand the importance of following safe practices while performing all shop operations. Specifically the student will be able to:

A. test the brakes before making any stall test on the vehicle.
B. install jack stands before working under the vehicle to remove transmission assembly.
C. fasten a safety chain around the transmission when using a transmission jack.
D. disconnect battery ground cable before removing the transmission.
E. safely connect pressure gauges.
F. demonstrate the proper procedure for towing a car equipped with an automatic transmission.

TEST

1. Which of the following would NOT be a proper procedure for evaluating basic automatic transmission difficulties?

    1. Check the engine to determine that it is sound mechanically and properly tuned
    2. Check the fluid for odor, discoloration, aeration, and signs of water
    3. Make a visual check for oil leaks
    4. Determine the correct end play clearance in the transmission
    5. Conduct a stall test according to the manufacturer's specifications

2. The turbine and the impeller in the automatic transmission are used to

    1. connect the torque convertor to the crankshaft.
    2. reverse the direction of the output shaft rotation.
    3. develop torque in the convertor.
    4. control the shift pattern at various road speeds.

3. Vortex oil flow is the

    1. circular motion of the oil between the two torus members.
    2. flow of oil in the direction of rotation of the torque convertor.
    3. oil flowing through the governor passage at road speed.
    4. method of making the transmission shift to low range.

4. Which of the following components controls vortex oil flow?

    1. Pump
    2. Turbine
    3. Sprag
    4. Pressure regulator
    5. Vanes

5. The secret of torque multiplication lies in the

    1. clutches.
    2. stator.
    3. servos.
    4. governor.

6. When the internal gear of the planetary gear set is held stationary, the other gears do which of the following?

    1. The sun gear drives and the planet carrier is driven.
    2. The sun gear holds steady and the planet carrier drives.
    3. The planet carrier and the sun gear are locked together.
    4. The planetary gear set turns as a complete unit to achieve direct drive.

7. To make external transmission adjustments it is necessary to use the inch/pound torque wrench on

    1. shift lever adjustments.
    2. the anti-stall throttle return dashpot.
    3. the neutral safety switch.
    4. the bands.

8. The manual control valve in the transmission is controlled by the

    1. pressure regulator.
    2. driver of vehicle.
    3. main valve body.
    4. servo.
    5. vacuum modulator.

9. Which of the following components must be activated by hydraulic pressure in order to apply the low band?

    1. Pump
    2. One-way clutch
    3. Governor assembly
    4. Servo piston
    5. Throttle valve

10. Which of the following components CANNOT be checked by using air pressure through the hydraulic pressure passages?

    1. Servos
    2. Pistons
    3. Bands
    4. Clutches
    5. Sprag

11. The rotor, slide, priming springs, torus feed valve and regulator valve are component parts of the

    1. connector.
    2. planetary gearset.
    3. main control valve body.
    4. front pump.
    5. clutch drum.

12. A servo in the transmission is used to

    1. apply clutches.
    2. apply bands.
    3. open the governor.
    4. activate the shift valve.

13. The opening and closing of the governor is controlled by the

    1. pump pressure.
    2. main control valve.
    3. pressure regulator.
    4. shifter valve.
    5. road speed.

14. The component part of the clutch assembly that needs replacing MOST frequently is the

    1. clutch pack.
    2. clutch piston.
    3. clutch spring/assembly.

15. If a driver complains of a loss of fluid and there are no visible signs of leaking noticeable, the problem would most likely be

    1. an internal leaking servo.
    2. a leaking modulator diaphragm.
    3. an oil filter screen leaking through.
    4. a leaking dashpot diaphragm.

16. To do a complete periodic maintenance check, which of the following would NOT apply?

    1. Check fluid pressure and vacuum at specified RPM
    2. Change filter and install correct gasket and fluid
    3. Check and adjust internal and external band adjustments
    4. Check modulator valve and connecting hoses
    5. Replace clutch piston at proper intervals

17. The following are some important safety rules to be used in automatic transmission repair. Which of these safety rules would NOT apply?

    1. Test the brakes before making a stall test on vehicle
    2. Install jack stands before working under a vehicle to remove the transmission
    3. Make sure the selector lever is in the park position before removing the transmission.
    4. Fasten safety chains around the transmission while it is on the transmission jack
    5. Safely connect pressure gauges, using caution with hot fluid.

18. A manual control linkage that is improperly adjusted would cause which of the following malfunctions?

    1. Will not downshift
    2. Harsh downshifts
    3. Car creeps in neutral
    4. Improper shift points

19. Gear ratio changes in an automatic planetary transmission are

    1. made by hydraulically operated bands or clutches which hold or release certain elements of the planetary gear train.
    2. obtained by sliding the synchronized planetary pinions into or out of mesh in the gear train.
    3. obtained by varying the volume of oil in the torque converter.
    4. obtained by engaging and disengaging the sun gear.

20. In automatic planetary transmissions, the fluid pressure required for the hydraulic control systems

    1. is taken from the torque converter pump outlet.
    2. does not vary regardless of the operating range used.
    3. is provided by the front pump.
    4. is provided by the servo.

21. When servicing the automatic transmission, it is necessary

    1. that every part be perfectly clean and very carefully handled.
    2. to coat parts with light graphite before reinstalling them.
    3. to use permatex or other sealers.
    4. to wipe all parts with a clean rag.

22. The flow of the oil under pressure to the various valves and passages in the band and clutch control system is controlled

    1. at all times by the position of the range control lever.
    2. by the governor in the transmission at all times.
    3. by the combination of the selector lever position, vehicle speed, and governor.
    4. by the opening and closing of the servo and band control valves.

23. When setting the engine idling speed on a car equipped with an automatic transmission

    1. the idle speed must be set first, then the throttle linkage must be reset to factory specifications.
    2. a vacuum gauge should always be used.
    3. set the speed 25 revolutions over the factory specifications.
    4. a tachometer must be used.

24. The torque converter stator redirects the oil flow to the

    1. turbine.
    2. impeller.
    3. transmission pump.
    4. lubricating system.

25. The torque converter provides its highest torque multiplication when

    1. turbine is stopped.
    2. impeller is stopped.
    3. turbine is moving at low speeds.
    4. impeller is moving at low speeds.

26. Operating a torque converter at low stall speeds will produce

    1. high torque multiplication.
    2. rapid heat buildup.
    3. excessive noise.
    4. good fuel economy.

27. Automatic transmission members are driven by the application of the

    1. clutches.
    2. bands.
    3. servos.
    4. synchronizers.

28. An ideal holding device would release at the instant torque reversal occurs in a planetary member. A device that does this in the automatic transmission is the

    1. piston clutch.
    2. sprag clutch.
    3. servo-operated band.
    4. link-operated band.

29. When checking automatic transmission fluid in a car, which of the following would NOT apply?

    1. Start the engine and warm it to normal operating temperature
    2. Place the gear selector in the park position
    3. Set the parking brake
    4. Speed the engine to 1000 RPM to circulate fluid properly

30. Which of the following is NOT a part of an automatic transmission?

    1. Planetary gear unit
    2. Torque converter
    3. Synchronizers
    4. Vacuum modulator

31. The converter

    1. is a fluid coupling device.
    2. provides torque multiplication.
    3. contains a stator.
    4. All of the above

32. The stator is connected to the transmission through the

    1. sprag clutch.
    2. disc clutch.
    3. lock-out clutch.
    4. fluid drive unit.

33. The shift points of an automatic transmission are influenced by the

    1. throttle pressure.
    2. vehicle speed.
    3. engine load.
    4. All of the above.

34. Which of the following does NOT influence the shift points?

    1. Vacuum modulator
    2. Vehicle speed
    3. Governor
    4. Hydraulic control pressures

35. Which of the following component parts creates reaction torque in a torque converter?

    1. Impeller
    2. Turbine
    3. Stator

36. Torque multiplication in a torque converter is greater at

    1. low speeds.
    2. cruising speeds.
    3. high speeds.

37. The manual shift valve is controlled by the

    1. pump oil pressure.
    2. governor speed.
    3. shift lever movement.
    4. manual clutch.

38. When towing a car with an automatic transmission for an extended distance with the rear wheels on the ground, which of the following would be the MOST important?

    1. Place the shift lever in neutral
    2. Remove the propeller shaft
    3. Place the shift lever in drive
    4. Drive at speeds below 25 M.P.H.

39. Most cars made after 1967 cannot be started by pushing. Which of the following component parts has been omitted to cause this situation?

    1. Planetary gearset
    2. Rear pump
    3. Modulator valve
    4. Sprag clutch

40. To make a stall test, the engine is operated at wide open throttle with the car brakes on and the transmission in

    1. neutral.
    2. park.
    3. high gear.
    4. low gear.

41. If the engine speed INCREASES excessively during the stall test, it is a sign that the

    1. oil level in the torque converter is high.
    2. transmission linkages require adjustment.
    3. bands or clutches slipping.
    4. planetary gears worn.

42. Automatic transmission fluid from a transmission in GOOD mechanical condition will usually be

    1. blue.
    2. red.
    3. green.
    4. black.

43. When stall testing, NEVER maintain the full throttle position for longer than

    1. five seconds.
    2. forty-five seconds.
    3. one minute.
    4. five minutes.

44. The vanes in a torque converter are

    1. flat.
    2. vertical.
    3. curved.

45. The three actions of the planetary gear system in the automatic transmission are to provide direct and reverse motion at the output shaft and to provide

    1. gear reduction.
    2. overdrive.
    3. gear increase.
    4. high gear.

46. The part in the clutch that puts the pressure on the clutch plates is called the

    1. spring.
    2. ring gear.
    3. drum.
    4. piston.

47. The valve which is controlled by linkage to the selector lever on the steering column is called the

    1. shift valve.
    2. manual valve.
    3. control valve.
    4. pressure regulator valve.

48. The device which operates the brake band is called the

    1. servo.
    2. valve.
    3. modulator.
    4. spring.

49. Applying the clutch to lock together two components of the planetary gear system produces

    1. reverse.
    2. overdrive.
    3. gear reduction.
    4. direct drive.

50. In which of the following positions should the neutral safety switch allow the engine to crank?

    1. Park
    2. Drive
    3. Neutral
    4. Reverse
    5. One and three above

51. Which of the following control vortex oil flow?

    1. Sprag
    2. Gear
    3. Vanes
    4. Pump

52. Sagging engine mounts can alter the

    1. throttle valve rod adjustment.
    2. downshift rod adjustment.
    3. selector rod adjustment.
    4. All of the above

53. Most band adjustments are made by

    1. turning a locknut and setscrew.
    2. adjusting the rod to proper torque in each gear.
    3. turning the servo pressure screw.
    4. torque the pressure regulator to factory specifications.

54. Which of the following is NOT a basic element of the torque converter?

    1. Pump
    2. Turbine
    3. Drum
    4. Stator

55. Which one of the following component parts is a part of the governor assembly?

    1. Cushion spring
    2. Primary weight
    3. Faced plate
    4. Roller clutch

56. The pressure regulator valve regulates the amount of pressure through

    1. spring pressure.
    2. water pressure.
    3. hydraulic pressure.

57. A ring gear used in an automatic transmission has

    1. teeth on the side.
    2. no teeth on the edge or rim of the gear
    3. teeth on the outside.
    4. teeth on the inside.

58. Which one of the following pumps is NOT used in automatic transmissions?

    1. Piston
    2. Gear
    3. Vane
    4. Rotor

59. The stator is also called the

    1. turbine.
    2. impeller.
    3. reactor.
    4. housing.

60. The moving part of a servo is the

    1. plunger.
    2. piston.
    3. diaphragm.
    4. boot.

61. A servo is a device that

    1. transforms hydraulic pressure into straight line mechanical pressure.
    2. transforms mechanical action into hydraulic action.
    3. transforms revolving action into hydraulic pressure.

62. When starting in the drive position in a single-range transmission, car motion will begin in

    1. low gear.
    2. intermediate gear.
    3. high gear.

63. When the front band is applied, the unit held stationary is the

    1. secondary sun gear.
    2. primary pinions.
    3. secondary pinions.
    4. internal gear.

64. When removing an automatic transmission, which of the following should be done first?

   1. Remove the transmission mounting bolts
   2. Drain the transmission fluid
   3. Chain the transmission to the jack
   4. Remove the negative battery cable

65. When making a visual check for oil leaks, which of the following would NOT be checked?

   1. Extension housing seal
   2. Pan gasket
   3. Pinion seal
   4. Front pump seal

66. When adjusting the anti-stall dashpot, which of the following WOULD apply?

   1. Adjust to the manufacturer's specifications
   2. Adjust with transmission in drive
   3. Adjust with the engine at 1500 RPM
   4. All of the above

In test items 67-72, select the defective component part most likely to cause the malfunction indicated. Write the answer in the space to the left of the malfunction.

MALFUNCTION

____ 67. No low gear
____ 68. No high gear
____ 69. Delayed or severe 1-2 shift
____ 70. Engine won't push start
____ 71. Acceleration normal, maximum speed about 50 mph
____ 72. Vehicle won't move in drive but will in low gear

DEFECTIVE PART

A. Governor
B. Servo or band
C. Clutch piston
D. Rear pump
E. Converter one-way clutch
F. Low servo piston check valve
G. Input shaft
H. Sprag

Match the component part in test items 73-78. Select from the list the component part which goes with the assembly indicated. Write the answer in the space to the left of the component assembly.

COMPONENT

____ 73. Planetary gearset
____ 74. Torque converter
____ 75. Clutch drum
____ 76. Main control valve
____ 77. Governor
____ 78. Front pump

ASSEMBLY

A. Stator
B. Governor plug
C. Pinion gears
D. Cushion spring
E. Rotor
F. Primary weight
G. Pan
H. Synchronizer

Unit: DRIVE LINE AND DIFFERENTIAL ASSEMBLY

Outline of Unit

I. Types of Drive Lines and Differential Assemblies

II. Technical Terminology

III. Use of the Service Manuals and Specifications

IV. Special Tools

V. Safety in Diagnosis and Repair

VI. Proper Interpretation of Trouble Shooting Results

Goal Statement

The automotive mechanic must be able to demonstrate his ability to successfully trouble shoot, make component repair or replacement decisions concerning any unit of the drive line and differential assembly encountered in the service setting and follow this with corrective action. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manuals. He also must be able to communicate effectively with other service personnel.

General and Specific Objectives

I. The student will understand the different types of drive lines and differential assemblies and their related parts. Specifically the student will be able to:

  A. explain the difference between an open, two piece, ball and trunnion, and a torque tube drive line.
  B. state the advantages of a two piece drive line over either the one piece drive line or a torque tube.
  C. identify the differences between a universal joint, a velocity joint, and a slip joint.
  D. explain the differences between a conventional and a non-slip differential assembly.
  E. describe the power flow in a conventional differential assembly.
  F. explain the power flow in a non-slip differential assembly.

II. The student will know the correct technical terms related to the drive line and differential assembly. Specifically the student will be able to:

   A. disassemble a drive line and identify each part.
   B. disassemble a conventional differential and identify each part.
   C. disassemble a non-slip differential and identify each part.
   D. given the manufacturer's method of identification, identify various drive line components.
   E. given a list of technical terms related to the drive line and differential assembly, define them.

III. The student will understand how to safely perform all the testing and diagnosis procedures on a vehicle with a malfunctioning drive line or differential assembly. Specifically the student will be able to:

   A. test a conventional differential for a malfunction using all safety precautions.
   B. test a non-slip differential for a malfunction.
   C. test a vehicle with an open drive line using all safety precautions.
   D. test a vehicle on a dynamometer observing all applicable safety precautions.
   E. overhaul an open, torque tube, or two piece drive line.

IV. The student will understand how to trouble shoot the drive line and differential assembly. Specifically the student will be able to:

   A. trouble shoot a malfunction in a conventional differential assembly.
   B. trouble shoot a malfunction in a non-slip differential assembly.
   C. order the correct parts necessary to overhaul a drive line or differential assembly.
   D. given a certain defective part, explain why it will cause a noise or a malfunction in the drive line.

V. The student will comprehend the construction, operation, and function of the drive line and differential assembly. Specifically the student will be able to:

   A. explain the construction and function of the drive line assembly.
   B. explain the function of the ring gear and pinion.
   C. explain the method of operation of a non-slip differential unit.
   D. explain how one rear wheel can turn independently of the other.

VI. The student will understand how to diagnose, repair, or replace any part in the drive line or differential assembly. Specifically the student will be able to:

   A. diagnose and repair a malfunction in the drive line or differential assembly.

B. given the manufacturer's specifications, replace an axle bearing.
C. given the manufacturer's specifications, adjust a differential assembly.
D. given the proper tools and the manufacturer's specifications, disassemble and reassemble a non-slip differential.
E. given the manufacturer's specifications, install a rear axle and adjust end play.
F. given the manufacturer's specifications, disassemble and reassemble a drive line.
G. use visual inspection to analyze defective parts.

VII. The student will understand the importance of knowing how to perform all the tests, adjustments, and repairs to the drive line and differential assembly at a rate of time that will meet or exceed industry standards. Specifically the student will be able to:

A. given the prescribed time limits, diagnose a differential noise.
B. given the prescribed time limits, replace a rear axle bearing.
C. given the prescribed time limits, overhaul a drive line with a defective part.
D. given the prescribed time limits, remove and replace a conventional differential.
E. given the prescribed time limits, overhaul a differential.

TEST

1. An open one-piece propeller shaft would have

    1. two universal joints and one slip joint.
    2. two universal joints and one velocity joint.
    3. two velocity joints and one universal joint.
    4. one universal joint and one slip joint.

2. The ADVANTAGE of a two-piece propeller shaft is that it allows

    1. a greater change in the angle between the transmission and the differential.
    2. a better body design.
    3. a better gear ratio.
    4. the use of a high speed transmission.

3. The difference between a universal joint and a velocity joint is that the velocity joint has a ball and socket plus

    1. two universal joints.
    2. one universal joint and one slip joint.
    3. two universal joints and one trunion.
    4. two slip joints and one universal joint.
    5. one universal joint and one center bearing.

4. The parts in a non-slip differential include a ring gear, a pinion gear, differential pinion gears,

    1. axle gears and a rotor.
    2. clutch plates and axle gears.
    3. a sprag clutch and axle gears.
    4. clutch plates and worm gears.

5. The path of the power flow in a conventional differential is pinion gear, ring gear,

    1. differential pinion gears, axle gears, axles and rear wheels.
    2. carrier cage, axle gears, axles and rear wheels.
    3. axle gears, differential pinion gears, cluster gear and rear wheels.
    4. differential pinion gears, axle gears, spur gears and rear wheels.

6. If one wheel tries to spin faster than the other, the non-slip differential becomes engaged and

    1. the wheel with less traction spins faster.
    2. the wheel with excessive traction spins faster.
    3. equal torque is applied to each wheel.
    4. None of the above

7. A two-piece propeller shaft consists of a slip joint and

    1. two universal joints, a velocity joint and a center bearing.
    2. two velocity joints, one universal joint and a center bearing.
    3. one universal joint, a center bearing and a pinion shaft.
    4. None of the above

8. Which of the following gears is NOT part of a conventional differential?

    1. Sliding gear
    2. Drive pinion gear
    3. Axle gear
    4. Ring gear
    5. Differential pinion gears

9. A differential with clutches is classified as a

    1. slipping.
    2. torque multiplier.
    3. non-slip.
    4. None of the above

10. The MOST popular type of universal joint in an open propeller shaft is a

    1. cross and roller.
    2. Hotchkiss joint.
    3. slip joint.
    4. spider and yoke.

11. Which of the following is the CORRECT adjustment sequence for a conventional differential assembly?

    1. Coast, drive, backlash, and pinion bearing preload
    2. Backlash, pinion preload, side carrier preload, and pinion depth
    3. Pinion depth, pinion bearing preload, side carrier bearing preload and backlash.
    4. Pinion bearing preload, side carrier bearing preload, coast and backlash.

12. Using a hydraulic post lift to test a conventional differential safely for a malfunction, it is necessary to

    1. check to see that the rear wheels are free to turn.
    2. place jack stands under the frame.
    3. free the rear tire treads of any foreign matter.
    4. remember to never put selector in reverse or park while rear wheels are turning forward.
    5. All of the above

13. It is necessary for both wheels on a locking differential to be off the floor when spin testing because

    1. one will not spin independently of the other.
    2. only one will lock unless spun at high RPM's.
    3. the left wheel spins counterclockwise and the right spins clockwise.
    4. All of the above

14. Using the hydraulic post lift to test for a defective universal joint in a vehicle with an open propeller shaft,

    1. speed the engine up 800 to 1000 RPM's, apply brakes and shift from low to reverse and observe slack and noise.
    2. speed the engine up 4000 to 5000 RPM's and shift from low to reverse rapidly and observe slack and noise.
    3. Run engine at 10,000 RPM's and check for vibration.
    4. None of the above

15. Which of the following is NOT considered a safety factor when testing a car on the dynamometer?

    1. Safety chains
    2. Set emergency brakes
    3. Wheel chocks
    4. Not exceeding torque load
    5. Not exceeding safe engine RPM

16. When overhauling an open propeller shaft, the bearing cups should NEVER be

    1. forced into their bores.
    2. packed full of grease.
    3. exposed to dirt or abrasives.
    4. None of the above
    5. All of the above

17. When overhauling a two-piece propeller shaft, care should be taken not to damage the ball and seat of the

    1. universal joint.
    2. slide joint.
    3. expansion joint.
    4. one-piece joint.
    5. velocity joint.

18. When road testing a car for a noise in the differential and it makes the noise only when making a turn, the MOST likely problem is a

    1. defective ring gear and pinion.
    2. bent drive shaft.
    3. defective universal joint.
    4. defective differential pinion and axle gears.

19. If a differential will make a noise only when coasting, the MOST probable cause is a(n)

    1. worn pinion bearing.
    2. improper backlash adjustment.
    3. defective axle bearing.
    4. defective side carrier bearing.
    5. improper pinion depth adjustment.

20. A non-slip differential has the same gears that a conventional differential has plus a

    1. spanner nut.
    2. torque sleeve.
    3. set of clutch plates.
    4. double reduction gear set.
    5. All of the above

21. When inspecting the bearings in a differential assembly, they should be replaced if they show signs of

    1. discoloration, pit marks or scoring.
    2. scoring, maladjustment or embedability.
    3. improper installation.
    4. All of the above
    5. None of the above

22. If it becomes necessary to replace a ring gear or pinion gear

    1. only the pinion gear can be replaced.
    2. only the ring gear can be replaced.
    3. the ring gear and pinion gear can be replaced as a set only.
    4. ring gear or pinion gear can be replaced if adjusted properly.
    5. the complete assembly must be replaced.

23. When replacing a spider and trunion universal joint, it is important to identify it by the

    1. type of transmission.
    2. type of vehicle and size of engine.
    3. manufacturer's name and if the joint is oversized.
    4. year of the vehicle.
    5. All of the above

24. In replacing a ring gear and pinion, if the pinion marking on the one being removed is a -2 and the one to be installed is a +2, they

    1. will not interchange.
    2. will interchange, if adjusted with the proper shim pack.
    3. must never be interchanged.
    4. can only be interchanged in case of emergency.
    5. can be interchanged since the markings are not important.

25. A defective pinion bearing will make a noise most likely

    1. when the vehicle is under a load or pulling.
    2. when the vehicle is coasting downhill.
    3. when rounding a curve only.
    4. at high speeds only.
    5. when idling at a stop light only.

26. A defective universal joint could cause a vibration plus

    1. a noise and slack when shifting gears.
    2. harsh shifting of gears.
    3. slow engagement of clutch.
    4. poor gasoline mileage.
    5. None of the above

27. In order to take care of the movement of the drive line caused by irregularities in the road it must have

    1. a solid connection from transmission to differential.
    2. a shock absorber at each end.
    3. a slip joint and a universal joint (or joints).
    4. three to six inches of free play at one end.
    5. None of the above

28. The purpose of a two-piece propeller shaft in a passenger car is to allow

    1. lowering of the hump in the floor pan.
    2. installation of a longer transmission.
    3. ease in removal and repairs.
    4. more economy in overhauling and repairs.
    5. a higher RPM and less vibration.

29. If a ring gear has 39 teeth and a pinion gear has 13 teeth, the ratio is

    1. 4 to 1.
    2. 3.1 to 1.
    3. 2.8 to 1.
    4. 4.1 to 1.
    5. 3 to 1.

30. When replacing a 3.11 differential with a 4.10 differential, the

    1. torque would be increased at the driving wheels.
    2. road speed would be increased.
    3. engine would turn less RPM's for the rear wheels to go the same speed.
    4. None of the above
    5. All of the above

31. The difference between a torque tube differential and a Hotchkiss is that the

    1. torque tube propeller shaft is open and the Hotchkiss is closed.
    2. torque tube propeller shaft is closed and the Hotchkiss is open.
    3. torque tube propeller shaft universal joints are easier to remove.
    4. torque tube propeller shaft drives through the leaf springs.
    5. Hotchkiss tube drives through a torque rod.

32. In order for one rear wheel to rotate faster than the other,

    1. two differential pinion gears and two axle gears are needed.
    2. the ring gear and pinion are needed.
    3. one large and one small axle gear are needed.
    4. one differential pinion gear and one axle gear are needed.
    5. one large differential pinion gear and one small axle gear are needed.

33. If an axle gear had a broken tooth, it would make a noise ONLY when

    1. moving in a straight direction.
    2. moving at high speeds.
    3. moving at low speeds.
    4. rounding a curve.
    5. in reverse.

34. When replacing most axle bearings, it is BEST to

    1. press them on when possible.
    2. drive them on with a punch and hammer.
    3. heat them with a torch and install by expansion.
    4. All of the above
    5. None of the above

35. On some vehicles after replacing an axle bearing, it is necessary to adjust the

    1. backlash.
    2. pinion depth.
    3. axle end play.
    4. pinion preload.
    5. pinion flange torque.

36. To check the differential backlash, it is necessary to use a

    1. torque wrench
    2. feeler gauge.
    3. micrometer.
    4. dial indicator.
    5. depth gauge.

37. The MAJOR difference between assembling a non-slip differential and a conventional type procedure is

    1. the installation of the clutch plates.
    2. the installation of the pinion gear.
    3. the installation of the ring gear.
    4. that all the adjustments are different.
    5. making the backlash adjustment.

38. Axle end play is adjusted by

    1. using shims between the drum and axle flange.
    2. torquing axle shaft nut to 250 ft. lbs.
    3. using shims between the axle housing and backing plate.
    4. using shims between the axle bearing and bearing race.
    5. using shims between the bearing and axle.

39. When overhauling a propeller shaft, it should be marked properly before disassembly

    1. for ease of reassembly.
    2. because it is a balanced unit.
    3. to save time on reassembly.
    4. All of the above
    5. None of the above

40. The method(s) of testing a differential for a noise would be to

    1. road test by accelerating and decelerating and listening for a noise change.
    2. place the vehicle on a hydraulic post lift and listening for a noise by running the vehicle in gear.
    3. spin one wheel at a time with the car on a floor jack and listening for a noise.
    4. All of the above
    5. None of the above

41. The QUICKEST recommended way to replace an axle bearing is to

    1. cut it off with a cutting torch and drive the new one on with a punch and hammer.
    2. press the bearings on and off with the proper tools and a hydraulic hand press.
    3. cut it off with a cold chisel and drive the new one on with a punch and hammer.
    4. Cut it off with a hacksaw and drive the new one on with a punch and hammer.
    5. heat the old one and drive it off and heat the new one and press it on.

42. The RECOMMENDED time to overhaul a one-piece open propeller shaft is

    1. one hour.
    2. four hours.
    3. six hours.
    4. eight hours.

43. The flat rate time to remove and replace a differential assembly is approximately

    1. two hours.
    2. eight hours.
    3. nine hours.
    4. twelve hours.
    5. sixteen hours.

44. In order to overhaul a differential in the minimum set time, which of the following is needed?

    1. Proper tools
    2. Specifications
    3. Proper replacement parts
    4. Skilled training
    5. All of the above

45. Which of the following is NOT a part of the differential assembly?

    1. Idler gear
    2. Ring gear
    3. Pinion gear
    4. Side gear

46. Which of the following is NOT a part of the limited-slip differential?

    1. Hypoid gears
    2. Flexible cross pins
    3. Friction clutch
    4. Sun gear

47. The STANDARD automotive differential has

    1. four gears.
    2. six gears.
    3. eight gears.
    4. ten gears.

48. When the two rear wheels are turning at different speeds, the

    1. differential pinion gear turns faster than the ring gear.
    2. two bevel side gears are locked together.
    3. differential pinion gear turns on its shaft.
    4. All of the above

49. On front wheel drive vehicles that have the transmission connected through the driving shafts to the front wheels, each drive shaft has

    1. a differential side gear.
    2. a universal joint.
    3. two universal joints.
    4. All of the above

50. A mechanic can correct an unbalanced propeller shaft by

    1. bending the shaft.
    2. adjusting the universal joints.
    3. adding wittek clamps.
    4. repositioning the shaft angles.

51. When the axle is removed from the housing of a passenger car, the bearing

    1. stays in the housing.
    2. stays in the differential.
    3. is ruined.
    4. comes out with it.

52. The inner ends of the axle shafts have splines that fit into splines in the

    1. wheel bearings.
    2. ring gear.
    3. bevel side gears.
    4. All of the above

53. The care of the universal joint MAINLY consists of periodic

    1. bearing replacement.
    2. adjustment.
    3. alignment.
    4. lubrication.
    5. All of the above

54. The type of joint that combines BOTH the universal and the slip joint in one assembly is the

    1. ball and trunion.
    2. mechanics.
    3. rzeppa.
    4. tracta.
    5. cross and roller.

55. Before removing the bearing caps, the

    1. cap and bearing should be marked.
    2. cap and housing should be marked.
    3. cap and bolts should be marked.
    4. bearing and housing should be marked.

In items 56-65 you will be given special instructions by your instructor. You will be evaluated on various performance jobs. (This is only a suggested list. It may vary to suit the instructor.)

56. Remove and replace a universal joint.

57. Remove and replace an axle shaft.

58. Remove and replace an axle bearing.

59. Replace and adjust a pinion gear.

60. Replace a ring gear and set backlash.

61. Make a coast and drive pattern.

62. Test a car for a defective drive line.

63. Test a car for a defective ring gear.

64. Test a car on a dynamometer.

65. Overhaul a non-slip differential.

Unit: THE BRAKE SYSTEM

Outline of Unit

I. Purpose and Basic Parts of the Hydraulic Braking System

II. Fundamentals of Hydraulics

III. Operation and Service of the Brake System

IV. Drum Brake Assembly

V. Disc Brake Assembly

VI. Emergency Brake Assembly

Goal Statement

The automotive mechanic successfully trouble shoots and makes component repair or replacement decisions concerning the brake system as encountered in the service setting and follows this with corrective action. The mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manuals. He also must be able to communicate effectively with other service personnel.

General and Specific Objectives

I. The student will understand the theoretical aspects of the hydraulic braking system. Specifically the student will be able to:

   A. given Pascal's Law, solve a problem concerning the operation of the hydraulic braking system.
   B. explain how piston sizes can control braking effort.
   C. explain friction as it relates to the operation of the braking system.

II. The student will understand how to use test equipment to diagnose brake problems. Specifically the student will be able to:

   A. use the drum micrometer to determine the condition of the brake drums.
   B. set up all test equipment quickly and correctly.
   C. use all test equipment correctly.
   D. use test results to determine brake condition.
   E. list malfunctions and their probable causes.

III. The student will understand the importance of using safe procedures during the maintenance and repair of the braking system. Specifically the student will be able to:

A. demonstrate the proper method of placing a vehicle on safety stands.
B. list unsafe conditions for repairing the braking system.
C. demonstrate the proper method for lifting heavy objects such as the wheel and drum assemblies.
D. explain the danger of an improperly grounded electrical tool.

IV. The student will understand how to perform repairs to the braking system. Specifically the student will be able to:

A. use the correct procedure to overhaul a brake master cylinder.
B. use the correct procedure to overhaul a brake wheel cylinder.
C. use the proper procedure to overhaul the power brake units.
D. use the proper procedure to overhaul a disc brake caliper.
E. use the correct procedure to install brake shoes.
F. use the correct procedure to perform emergency brake adjustments.
G. compare the operation of an electric brake system with the operation of an hydraulic system.
H. given the parts of a brake unit, arrange them in order.
I. explain when a brake drum needs resurfacing.
J. given different braking systems, describe the operation of each.
K. explain the need for cam grinding brake shoes.
L. state the need for "true" rotor in disc brakes.

V. The student will understand the importance of effective communication. Specifically the student will be able to:

A. demonstrate his ability to read and comprehend service manuals.
B. use correct brake terminology.
C. justify the needed repairs to a customer.

VI. The student will understand how to operate all the equipment used in brake repair work. Specifically the student will be able to:

A. demonstrate proper procedures in using a pressure bleeder.
B. demonstrate proper procedures in using a drum/disc lathe.
C. correctly use a cam grinder.

TEST

1. If the master cylinder provides 500 P.S.I., how much pressure will be provided at a two-inch wheel cylinder?

   1. 100 P.S.I.
   2. 250 P.S.I.
   3. 500 P.[illegible]
   4. 750 P.S.I.

2. Which statement BEST describes disc brakes as related to drum brakes?

   1. Disc brakes are more effective due to larger cylinders.
   2. Disc brakes require less pressure to stop the vehicle.
   3. Disc brakes are less effective due to a smaller friction area.
   4. Disc brakes are new while drum brakes have been used for many years.

3. Braking effect would be INCREASED by

   1. using larger wheel cylinders.
   2. using a smaller diameter wheel and drum.
   3. using smaller wheel cylinders.
   4. sliding to a stop rather than slowing to a stop.

4. There is a limit on the amount of material that can be removed from a brake drum because

   1. the brake shoes would not fit the drum.
   2. the brake drum would give away under stress.
   3. there would be a "grab" during brake applications.
   4. the brake drum would hold heat too long.

5. Two gauges are used to test a metering valve. The gauge on the rear wheel brake line will read

   1. zero P.S.I. while the front line reads 10 P.S.I.
   2. 15 P.S.I. as will the front wheel line.
   3. the same as that on the front wheel line.
   4. 30 P.S.I. before the front wheel line will start to read.

6. Slight scores or roughness of the brake drum

   1. indicate the need for a new drum.
   2. should be removed by using a drum lathe.
   3. does not impair braking action.
   4. indicates that the brake shoes need cam grinding.

7. Which of the following is the BEST place to position safety stands?

   1. Springs and spring seats
   2. Engine mounts and differential housing
   3. Front and rear bumpers
   4. Frame and lower control arms

8. When using a bumper jack, which of the following is considered a CORRECT procedure?

    1. While on a grade, lift the vehicle with the transmission in park
    2. While on a level surface, lift the vehicle with the transmission in neutral
    3. Lift the vehicle by the side frame
    4. While on a level surface, lift the vehicle with the transmission in park

9. Which is the BEST method for manually lifting heavy objects?

    1. Bend over and lift with the back
    2. Lift from the side, using arm strength
    3. Use both legs and back to lift
    4. Squat and lift with the legs, keeping back straight

10. Which of the following is the PROPER connection for a three-prong 110 volt plug?

    1. Black wire to brass, white wire to steel, green wire to long prong
    2. Green wire to brass, white wire to steel, black wire to long prong
    3. White wire to brass, other two can fit either way
    4. Green wire to steel, black wire to long prong, white wire to brass

11. Which of the following is NOT part of the master cylinder assembly?

    1. Secondary cup
    2. Spool valve
    3. Primary cup
    4. Residual valve

12. Residual pressure is needed in a hydraulic brake system in order to

    1. reduce the amount of pressure needed on the brake pedal.
    2. prevent air from entering the hydraulic system.
    3. keep the fluid at a proper level in the master cylinder.
    4. reduce the clearance between the brake shoe and drum.

13. If the master cylinder vent is plugged, it is probable that

    1. the vacuum created will cause erratic pedal stroke.
    2. air will enter the system due to the vacuum created.
    3. the wheel cylinder will leak fluid due to the vacuum created.
    4. nothing will happen, since the vent is used to remove moisture only.

14. Master cylinder "buildup" is NOT caused by

    1. a swelled secondary cup.
    2. an out-of-adjustment master cylinder link pin.
    3. air in the system.
    4. contaminated fluid.

15. Which is the CORRECT procedure to bleed brakes manually?

    1. The bleeder must be closed before the pedal is released.
    2. The bleeder must be open when the pedal is released.
    3. The filler cap of the master cylinder must be open.
    4. The bleeder must be open during the entire operation.

16. Which statement is NOT true regarding power brakes?

    1. Some power brake units are of the atmospheric suspension type.
    2. Some power brake units are of the vacuum suspension type.
    3. Power brakes and booster brakes are the same thing.
    4. Power brakes use a combination of atmospheric and vacuum forces to operate.

17. Which statement is NOT true regarding disc brakes?

    1. Some disc brake calipers use one piston.
    2. Disc brake calipers must be removed to remove rotors.
    3. Some disc brake calipers use four pistons.
    4. Caliper pistons use return springs.

18. The secondary brake shoe of a "floating anchor" braking system is a

    1. long lining and is located toward the rear of the backing plate.
    2. short lining on the rear of the backing plate.
    3. long lining on the front of the backing plate.
    4. short lining on the rear of the backing plate.

19. Which is the LEAST correct brake service statement?

    1. When a brake drum is oversized, oversized lining is needed.
    2. Some rivets will not score a drum.
    3. Drum "hard spots" will cause brake problems.
    4. Drums machined more than .090 are considered safe.

20. Self-adjusting brakes will adjust themselves

    1. when the brake pedal is pumped up.
    2. after the pedal is applied and the vehicle is moving backward.
    3. when the emergency brake is applied.
    4. after the pedal is applied and the vehicle is moving forward.

21. Color coding of the brake spring is necessary for several reasons. Which of the following is INCORRECT?

    1. Coding is used to stock springs at the factory.
    2. Coding is used to indicate the strength of the spring.
    3. Coding is used to indicate the size of the vehicle a spring will be used on.
    4. Coding is used to locate the spring on the backing plate properly.

22. The term self-energizing refers to the effect on the

    1. friction between the tire and the road.
    2. pressure of the hydraulic fluid.
    3. friction between the brake shoe and drum.
    4. rear brake shoes only.

23. Select the BEST statement relating to emergency brake adjustment.

    1. There is no adjustment.
    2. Adjustment is made by shortening the cable linkage.
    3. Emergency brakes are self-adjusting.
    4. Emergency brakes adjust when normal shoe adjustment is made.

24. Emergency brakes are released by several methods. Which of the following is NOT a release method?

    1. Vacuum power
    2. Pull cable
    3. Electro-magnetic
    4. Foot trip

25. Which of the following statements does NOT reflect emergency brake operation?

    1. Emergency brakes use all four rear shoes.
    2. Emergency brakes are on the drive line of some cars.
    3. The park feature of some transmissions is an emergency brake.
    4. Some cars use rear wheel shoes for emergency brakes.

26. Which statement is CORRECT in reference to a duo-servo wheel cylinder brake system service?

    1. Hone, then install spring, two cups and two pistons
    2. Hone, then install spring, one cup, one piston
    3. Hone, then install two springs, large and small cups and pistons
    4. All of the above

27. The PROPER toe and heel clearance between brake shoe and drum is

    1. .015 inch.
    2. .030 inch.
    3. .050 inch.
    4. .005 inch.

28. Brakes are classified by the way they are applied. Which of the following is NOT a brake classification?

    1. Vacuum
    2. Hydraulic
    3. Mechanical
    4. Electrical

29. The reason for cam grinding brake shoes is to REDUCE

    1. the pedal effort.
    2. the heat on the brake shoes.
    3. the coefficient of friction.
    4. improper shoe to drum contact.

30. Warped rotors will NOT cause

    1. fluid loss.
    2. the driver's foot to pulsate.
    3. the brake pads to run hotter than normal.
    4. premature wear on the brake pads.

31. When specifications state plus (+) or minus (-), what does the manual mean?

    1. A greater or fewer number of cylinders
    2. More or less parts to a cylinder
    3. Normal reading tolerances
    4. Any reading will do

32. Which of the following is NOT correct in reference to brake systems?

    1. The fluid transfers effort from the master cylinder to the wheel cylinder.
    2. Copper lines make the best fluid lines.
    3. Pads and calipers are parts of a braking system.
    4. Heat will cause out-of-round drums.

33. Which statement below is NOT a good justification for brake repair?

    1. The brake drum is scored due to rivet contact.
    2. Fluid is present in the dust boot.
    3. The rivets are 1/64" from drum contact.
    4. Rain soaked linings require replacement.

34. Select the statement that BEST describes dual master cylinder bleeding with connecting reservoirs (pressure bleeder hookup).

    1. Attach pressure bleeder to one filler hole with the other one sealed
    2. Apply twice normal air pressure in order to bleed properly
    3. Connect pressure bleeder to one filler hole with the other one open
    4. The pressure bleeder cannot be used on this type of cylinder.

35. Which statement LEAST describes a pressure bleeder?

    1. It is a one-man operation.
    2. All cylinders can be bled at one time.
    3. It does a better job than manual bleeding.
    4. It operates on single and dual master cylinders.

36. Which of the drums listed should NOT be "turned" and placed in service?

    1. A drum with hot spots
    2. A drum with a groove .085 inch deep
    3. An out-of-round drum
    4. A tapered or "bell mouth" drum

37. When turning a drum, sparks from the cutting tool indicate

    1. normal operation.
    2. that the drum is turning too fast against the cutter.
    3. that the cutter is moving across the drum too slowly.
    4. that the cutter is dull.

38. When arboring a drum, which statement is NOT acceptable? (Placement on lathe)

    1. Upright support and center cone is used on a drum without a hub.
    2. Taper cones are used in roller bearing hubs.
    3. Radius cones are used in ball bearing hubs.
    4. Upright support will center a drum without a hub.

39. The cam grinder usually will clear up all of the problems below EXCEPT

    1. the pedal pulsations felt by the driver.
    2. pulling to the right due to the unequal diameter of the front drums.
    3. the noise due to poor shoe to drum contact.
    4. hard pedal pressure due to glazed brake linings.

40. Which of the following air compressor maintenance steps is NOT needed?

    1. Air tank drained of water
    2. Air filter cleaned
    3. A Freon check
    4. Crankcase oil changed

41. A brake drum micrometer is a combination of which of the following measuring instruments?

    1. A ruler and a scale
    2. A feeler gauge and a scale
    3. The dial indicator and feeler gauge
    4. The dial indicator and ruler

42. The ideal lining for any particular vehicle is the lining which

    1. has the highest coefficient of friction.
    2. has the most wear resistance.
    3. is designed for that particular vehicle.
    4. has the softest lining.

43. A damaged grease seal may cause the brake to

    1. drag.
    2. overheat.
    3. pull to one side.
    4. All of the above

44. When the pedal is released, brake fluid is forced back into the master cylinder by

    1. the brake shoe retracting spring.
    2. the spring on the brake pedal.
    3. the spring in the master cylinder.
    4. the vacuum from the master cylinder.

45. How are brakes designed in reference to the USUAL braking effort?

    1. Equal at the front and rear of the vehicle
    2. Front wheel 60 percent, rear wheel 40 percent
    3. Rear wheel 60 percent, front wheel 40 percent
    4. Front and rear equal but front will apply first

46. Which statement is TRUE in regard to the adjustment of disc brake pads?

    1. Change the return spring to adjust
    2. Turn a screw to adjust
    3. They are self-adjusting
    4. Turn a cam to adjust

47. The CORRECT procedure for bleeding brakes is to bleed

    1. left front, right front, left rear, right rear
    2. right front, left front, right rear, left rear
    3. left front, left rear, right front, right rear
    4. in any order.

48. In the hydraulic brake system, movement of the master cylinder piston forces fluid

    1. out of the fluid reservoir.
    2. into the power piston.
    3. into the hydraulic cylinder.
    4. into the wheel cylinder.

49. When cleaning fluid is forced from the master cylinder through the wheel cylinder, the operation is called

    1. flushing.
    2. bleeding.
    3. filling.
    4. cleaning.

50. In disc brakes, the movement of the caliper piston forces the brake lining against the

    1. drum.
    2. disc (rotor).
    3. caliper.
    4. wheel.

51. The anti-skid device operates

    1. only during low speed braking.
    2. only during high speed braking.
    3. when the wheel tends to stop turning.
    4. any time that braking is done.

52. The Sure-Track anti-skid system uses a vacuum-powered activator, an electronic control module and

    1. a load sensing valve.
    2. transmission sensors.
    3. a governor.
    4. wheel sensors.

53. When reassembling a master cylinder, lubricate all parts with

    1. oil.
    2. brake fluid.
    3. cup grease.
    4. mineral oil.

54. The clearance between the piston and the master cylinder wall is NOT acceptable if the reading is over

    1. .001 inch.
    2. .002 inch.
    3. .004 inch.
    4. .005 inch.

55. When a rubber brake hose shows a crack in the outer coating, the hose is

    1. unacceptable and must be replaced.
    2. all right since the outer coat always cracks from flexing.
    3. dangerous and the driver should be warned.
    4. indicative of an improper joint.

Unit: SUSPENSION AND STEERING

Outline of Unit

I. Introduction

II. Frame

III. Front Suspension

IV. Rear Suspension

V. Tires and Wheels

VI. Front End Alignment

Goal Statement

The automotive mechanic must be able to demonstrate his ability to successfully trouble shoot and make component repair or replacement decisions concerning any unit of the suspension and steering system. He must have the job entry level skills required of the trade. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins, flat rate time manual and be able to communicate effectively communicate with other service personnel.

General and Specific Objectives

I. The student will understand the mechanical and scientific principles involved in the steering of a vehicle. Specifically the student will be able to:

A. identify the different steering gears used.
B. point out the places of stress and expected wear.
C. given any part of a steering gear, recognize it and state its purpose.
D. cite examples of a bad steering gear operation.
E. given parts of a power steering unit, identify them.

II. The student will comprehend the function of the suspension system and the scientific principles involved. Specifically the student will be able to:

A. recognize the different types of suspension systems.
B. given different types of frames, compare their use.
C. describe the different types of rear suspension used.
D. point out the need for correct wheel alignment.
E. state the reasons why shock absorbers are needed.
F. state the purpose of an automatic level control.

III. The student will know the correct technical terms relating to steering and suspension systems. Specifically the student will be able to:

- A. given parts related to steering and suspension system, identify them.
- B. given any part of a disassembled steering gear, identify it.
- C. use factory service manuals effectively.
- D. define such terms as camber, caster, and steering axis.

IV. The student will understand the importance of having sufficient manipulative skills related to steering and suspension systems. Specifically the student will be able to:

- A. given the manufacturer's specifications, align a vehicle.
- B. given a tire wear problem, diagnose the probable cause.
- C. use a wheel balancer properly.
- D. given any part of a front end, select the proper procedure for repairing and replacing it.

V. The student will understand the importance of orderly, clean, and safe working habits. Specifically the student will be able to:

- A. given unclean working conditions, explain possible job outcomes.
- B. explain the potential dangers involved with a car on machine lifts.
- C. list ways to properly care for tools and equipment.
- D. explain the dangers involved in the replacement of coil springs.
- E. given a certain job, choose the necessary tools.

TEST

1. Which of the following gear boxes is MOST frequently used in American cars?

    1. Worm and roller
    2. Reciprocating ball and nut
    3. Rack and pinion
    4. Worm and stud

2. In steering gears using a tooth roller, the tooth roller is in mesh with the

    1. worm.
    2. sector.
    3. steering shaft.
    4. pitman arm.

3. While steering gear bearings suffer some wear, which parts COMMONLY show wear in a worm and roller gear?

    1. Sector shaft to pitman arm
    2. Steering shaft to column
    3. Sector shaft itself
    4. Worm and roller

4. The BEST way to check wear on ball joints is to

    1. remove the weight from the joint.
    2. make sure weight is on joint.
    3. grease joint to remove slack.
    4. grasp tire front and rear and shake it.

5. The sector shaft has the gear sector at one end and the

    1. worm shaft at the other end.
    2. pitman arm at the other end.
    3. ball nut at the other end.
    4. steering wheel at the other end.

6. How many total number of bearings does the sector shaft use?

    1. 1
    2. 2
    3. 3
    4. 4

7. When turning wheels from one stop to the other with a car jacked up, a rough feel in steering indicates

    1. a normal feel.
    2. a bad pitman arm.
    3. rough worm bearings.
    4. pitted sector shaft bearings.

8. If the wheels are straight ahead and there is too much slack caused by the steering gear, then it is necessary to adjust the

    1. ball nut to worm.
    2. worm bearing.
    3. sector to pitman arm.
    4. Any of the above

9. Two basic types of power steering systems are the

   1. integral and valve.
   2. booster and power.
   3. valve and linkage.
   4. integral and linkage.

10. Three types of oil pumps used in power steering systems are the slipper, vane and

    1. piston.
    2. roller.
    3. gear.
    4. shoe.

11. While most front ends use ball joints, the twin I beam (for pivot and support) uses

    1. king pins.
    2. ball and trunion.
    3. ball and socket.
    4. trunions.

12. In torsion bar suspension, the springing action is produced in the long bars by

    1. compression.
    2. expansion.
    3. a twisting action.
    4. a slipping action.

13. Uni-body construction refers to a vehicle with

    1. no frame, but body is stressed.
    2. short frames and stressed body.
    3. "X" frame and body bolted on.
    4. box frame and body bolted on.

14. Which of the list below is NOT a frame used for a vehicle?

    1. Uni-body construction
    2. Boxed
    3. "X" plus boxed
    4. Wedged

15. Twisting force is absorbed in the rear suspension with coil springs by the

    1. springs themselves.
    2. torque arm.
    3. sway bar.
    4. shock absorbers.

16. Rubber bushings are used in spring eyes to

    1. make them easier to remove.
    2. suppress vibrations and noise.
    3. reduce wear on metal parts.
    4. All of the above

17. If a vehicle pulls constantly to one side, caused by misalignment, then there is an indication that which of the following is INCORRECT?

    1. Camber
    2. Toe-in
    3. Caster
    4. Turning radius

18. If a vehicle has excessive tire wear on the outside of treads, caused by misalignment, then there is an indication that which of the following is INCORRECT?

    1. Camber
    2. Toe-in
    3. Caster
    4. Turning radius

19. The suspension springs' oscillation is controlled by the

    1. torque arm.
    2. radius rods.
    3. sway bar.
    4. shock absorbers.

20. While springs normally hold curb height of the vehicle, shock absorbers sometimes also lift if they are of the

    1. air-oil type.
    2. air-oil with a pump type.
    3. heavy duty type.
    4. All of the above

21. The automatic level control includes the air pressure lines, special shock absorbers, a control valve and the

    1. intake manifold.
    2. compressor.
    3. rear springs.
    4. sway bar.

22. The essential difference between standard shock absorbers and the super-lift shock absorbers used in the automatic level control is that the super-lift

    1. is larger.
    2. acts slower.
    3. acts faster.
    4. has a sealed air chamber.

23. In the steering system, the pitman arm is splined to the

    1. steering arm.
    2. tie rod.
    3. sector shaft.
    4. car frame.

24. The devices attached to leaf springs which permit the springs to change in length as they flex are called

    1. hooks.
    2. bolts.
    3. hangers.
    4. shackles.

25. Which of the following is a part of the steering gear assembly?

    1. Slack adjuster
    2. Drag link
    3. Steering arm
    4. Idler arm

26. Which of the following is NOT a part of a power steering assembly?

    1. Reciprocating ball and nut
    2. Piston
    3. Spool valve
    4. Slipper

27. The following question requires the use of a specification manual. Which of the following is a good front end setting for a 1970 Chevrolet car with a V-8 engine?

    1. Caster +3/4°, camber +1/4°, toe-in 1/8"-1/4" in
    2. Caster 0°, camber 0°, toe-in 0"
    3. Caster -1/2°, camber -1/4°, toe-in 1/16" in
    4. Caster +1/4°, camber +1°, toe-in 1/16" out

28. If flat rate time is 1.5 hours and the labor rate is $8.00 per hour, the correct labor charge is

    1. $10.50
    2. $11.50
    3. $12.00
    4. $13.00

29. Which of the following is NOT a method of changing the camber and caster?

    1. Intershaft slips on an elongated bolt hole
    2. Change the height of the spring lift
    3. Turn cam on lower intershaft and bushing
    4. Shims placed between intershaft and frame

30. In relationship to the front of the vehicle, the positive caster inclines the spindle support in which of the following directions?

    1. Toward the front
    2. Out from center
    3. In from center
    4. Toward the rear

31. A sawtooth tread wear pattern indicates misalignment of the

    1. turning radius.
    2. camber.
    3. caster.
    4. toe-in.

32. While worn parts will cause irregular tire wear, a deep cup followed by smaller ones indicates problems with

    1. a static unbalanced wheel.
    2. the toe-in.
    3. the camber.
    4. the caster.

33. The procedures for using a wheel balancer are different according to the make of the vehicle. However, for all vehicles it is necessary to

    1. wash the wheel and tire.
    2. gauge the tire pressure.
    3. remove rocks from the tire tread.
    4. mark the tire to the rim.

34. Dynamic unbalance is corrected by installing weights on the wheel

    1. directly across from each other.
    2. diagonally to each other.
    3. top and bottom on the same side.
    4. All of the above

35. Ball joints are installed in many ways. Which of the following is NOT a method used?

    1. Bolted
    2. Threaded
    3. Rivets
    4. Pressed
    5. Welded

36. To remove coil springs, it is necessary to jack up the car, remove the wheel assembly, remove the shock and sway bar linkage, and then lower the spring out by

    1. loosening the lower ball joint stud, lowering the A-frame, removing the coil.
    2. loosening the intershaft, lowering the A-frame, removing the coil.
    3. loosening the ball joint stud and intershaft, lowering A-frame and coil together.

37. A pitted condition in the wheel bearings is MOST likely caused by lack of lubrication or by

    1. chemicals.
    2. dirt.
    3. moisture.
    4. heat.

38. Which of the list below is NOT a good lubrication for wheel bearings?

    1. Moly-based
    2. A mixture of molylithium and sodium-based lubrication
    3. Lithium-based
    4. Sodium-based

39. When a bumper jack is used to lift the front of a vehicle, for safety reasons the rear wheels must be

    1. locked.
    2. jacked first.
    3. free to roll.
    4. chocked.

40. Which of the following is NOT true concerning the safe installation of a vehicle on a front end machine?

    1. Chock the wheels
    2. Leave the wheels unchocked
    3. Make sure the wheels are at the center of the rack
    4. Turn off the ignition switch with the car in park gear

41. Air compressors need periodic service. Which of the following services is NOT needed?

    1. Clean and/or replace air filter
    2. Change lubrication oil
    3. Drain moisture from air tank
    4. Change oil filter

42. The fluid that is used to fill service floor jacks is

    1. hydraulic oil.
    2. brake fluid.
    3. transmission fluid.
    4. shock oil.

43. When replacing coil springs on the front suspension, the coils should be

    1. held by hand while jacking into place.
    2. retained with a special locking device.
    3. positioned on an A-frame and jacked without holding.

44. Coil springs are USUALLY held in position by

    1. being bolted to the frame.
    2. being clamped to the frame.
    3. pressure or weights.
    4. shackles.

45. To remove a tire rod end that is to be used again, remove the nut and then

    1. hit the top of the stud with a hammer to break it loose.
    2. use a puller to remove the ball stud.
    3. use a forked knocker to remove the ball stud.
    4. ball stud will drop out.

46. The BEST pliers to use for removing cotter pins are

    1. needle-nosed.
    2. waterpump (offset jaw).
    3. diagonal.
    4. combination slip-joint.

47. The springing action of the torsion bar is produced by

    1. compression.
    2. a twisting action.
    3. friction.
    4. a slipping action.
    5. a pulling action.

48. Which of these would NOT cause a hard steering problem?

    1. Tightened pulley
    2. Glazed belt
    3. Steering sockets dry
    4. Uneven tire pressure

49. Which of the following causes low steering pump pressure?

    1. Worm gear not preloaded
    2. Steering arm loose
    3. Belt oily
    4. Control valve stuck

50. Which of the following is a part of the frame?

    1. Wheel house panels
    2. Springs
    3. Cross members
    4. Drive shaft

51. Which of the following BEST describes integral frame and body construction?

    1. Structural strength members
    2. Unitized
    3. Partial frame
    4. Separate steel frame
    5. Short stub frame

52. Which of the following would be considered SAFE wearing apparel?

    1. Goggles
    2. Watches
    3. Rings
    4. Loose fitting clothing

53. Which of the following tires would have the MOST strength?

    1. 2 ply/4 ply rating
    2. 4 ply rating
    3. 6 ply rating
    4. 8 ply rating

54. Which of the following bearings is COMMONLY used in automobile front wheels?

    1. Sleeve
    2. Precision insert
    3. Bronze
    4. Needle
    5. Roller

55. A misaligned suspension will NOT cause

    1. the tires to squeal on turns.
    2. hard steering.
    3. excessive tire wear.
    4. a pull to one side.
    5. excessive strain on the springs.

56. Which of the following is NOT found in the independent front wheel suspension system?

    1. Ball joints
    2. Solid front axle
    3. Coil spring
    4. Shock absorber
    5. Pitman arm

In items 57-61 select the proper response from the list of terms A-F appearing to the right of the page which best satisfies the definition. Place your answer in the blank to the left of the definition. An answer may be used more than once or not at all.

DEFINITION

___57. Used for steering stability
___58. Control compression and rebound
___59. Proper setting will correct car pulling to one side
___60. Improper setting causes wear to tread edge
___61. Refers to alignment of frame to axles

TERM

A. Camber
B. Shock absorbers
C. Tracking
D. Caster
E. Turning radius
F. Coil spring

In items 62-67 select the proper response from the list of causes A-J appearing to the right of the page which best explains the fault appearing in the list to the left of the page. Place your answer choice in the blank to the left of the fault. An answer may be used more than once or not at all.

FAULT

___62. Wheel assembly tilting in or out at the top from true vertical
___63. Tends to return wheels to straight ahead out of a turn
___64. Suspension or king pin turns forward or backward
___65. Front wheels try to run together as vehicle moves forward
___66. Causes spindle to rise or fall as wheels are turned right or left respectively
___67. Keeps wheels from dragging in a turn

CAUSE

A. Toe-in
B. Wheel balance
C. Camber
D. Worn ball joints
E. Worn idler arm
F. Torsion bar
G. Steering linkage
H. Toe-out
I. King pin inclination
J. Caster

Items 68-69 require actual shopwork and the use of special tools. Follow your instructor's directions very carefully and try to do the best possible job with each of the tasks.

68. Disassemble, inspect, and reassemble a typical power steering pump.

69. Complete a simulated front end alignment of a typical automobile manufactured in America.

Unit: THE VENTILATION SYSTEM

Outline of Unit

I. Fresh Air Venting Systems

II. Heating Systems

  A. Operation
  B. Service

III. Air Conditioning Theory and Operation

IV. Air Conditioning Service

Goal Statement

The automotive mechanic successfully trouble shoots, makes component repair or replacement decisions concerning any unit of the ventilation system encountered in the service setting and follows this with corrective action. The automotive mechanic must accomplish these tasks with both speed and accuracy at a level which will meet or exceed dealership job entry level requirements, while observing rigid personal and mechanical safety practices. The automotive mechanic must be knowledgeable and proficient in equipment use and in the utilization of technical publications such as service manuals, service bulletins and flat rate time manuals. He also must be able to communicate effectively with other service personnel.

General and Specific Objectives

I. The student will understand the importance of a properly operating ventilation system. Specifically the student will be able to:

  A. list the dangers of an improperly vented automobile.
  B. state the relationship of driver comfort to automobile safety.
  C. list maintenance procedures which prolong the system's performance.

II. The student will understand the technical terms related to the ventilating systems. Specifically the student will be able to:

  A. given various terms related to the ventilating system, match them with the correct definition.
  B. state possible system malfunctions and their repair, using the proper technical terms.
  C. utilize proper terminology in discussing the repair or service of the system's components.
  D. given a schematic drawing of the system, correctly label system parts and assemblies, using manufacturers' terminology.

III. The student will understand how to safely perform the required testing and diagnosis (using applicable test equipment) of the ventilating system. Specifically the student will be able to:

- A. identify safe shop procedures.
- B. safely trouble shoot heater fan and switch for malfunction.
- C. test a thermostat for proper operation.
- D. trouble shoot vacuum motors using a vacuum gauge.
- E. demonstrate the use of the air conditioning leak tester.
- F. pressure test the air conditioning system, using proper test equipment.
- G. determine the oil level of the system.
- H. use the belt-tensioning gauge.
- I. utilize a voltmeter to test a magnetic clutch.
- J. test the system for low refrigerant level.

IV. The student will understand the construction and operation of all the system's components. Specifically the student will be able to:

- A. describe heater blower/motor operating theory.
- B. adjust fresh air vent.
- C. disassemble compressor, identify parts and reassemble.
- D. disassemble expansion valve, identify parts and reassemble.
- E. trace the heater electrical circuit and state the function of each component involved.

V. The student will comprehend the function of ventilating system components. Specifically the student will be able to:

- A. state the three means of heat transfer.
- B. state the basic laws of hydraulics and pneumatics.
- C. use a pressure gauge to explain the operation of the compressor, evaporator and condenser.
- D. describe the three functions of an air conditioning system.
- E. trace refrigerant flow in an air conditioning system and state the function of each component.

VI. The student will understand the importance of knowing how to safely adjust and repair components of the ventilating system at a rate of time that will meet or exceed industry standards. Specifically the student will be able to:

- A. install and adjust cowl vent door cables.
- B. remove, test and replace the heater core.
- C. install a heater hose correctly.
- D. test heater blower motor and switches for malfunctions.
- E. install a thermostat.
- F. given a specific air conditioner, determine the refrigerant level.
- G. conduct leakage tests for the air conditioning system.
- H. install an air conditioning compressor.
- I. install an expansion valve.
- J. conduct purging, evacuating and charging of the air conditioning system.

TEST

1. The MOST important function of automobile ventilation systems is to
    1. increase the resale value of the automobile.
    2. provide clean air for the occupants.
    3. improve safety by having less driver fatigue.
    4. permit operation of the automobile under all climatic conditions.

2. Heat may be transferred by
    1. radiation.
    2. convection.
    3. conduction.
    4. All of the above

3. Essentially, the process of cooling means
    1. evaporation.
    2. removal of heat.
    3. melting.
    4. removal of moisture.

4. As the pressure on a liquid is lowered, the boiling point is
    1. raised.
    2. held steady.
    3. lowered.
    4. None of the above

5. "B.T.U." refers to the amount of heat required to
    1. raise the temperature of 1 pound of water 1 degree Fahrenheit.
    2. cool the temperature of 1 gram of water 1 degree Fahrenheit.
    3. raise the temperature of 1 gram of water 1 degree Fahrenheit.
    4. raise the temperature of 1 ounce of water 1 degree Fahrenheit.

6. The MOST probable cause for a heater to blow cold air is that the
    1. heater hoses have collapsed.
    2. thermostat is stuck open.
    3. radiator pressure cap is not working properly.
    4. window vents are not closed.

7. Heater controls are operated by
    1. vacuum and pressure.
    2. pressure and cables.
    3. cables only.
    4. vacuum and cables.

8. The air conditioning system absorbs heat by

    1. boiling liquid refrigerant.
    2. cooling with refrigerant vapors.
    3. circulating cold refrigerant.
    4. cooling with liquid refrigerant.

9. When Freon 12 comes into contact with an open flame, it

    1. is harmless.
    2. may explode.
    3. becomes a toxic gas.
    4. burns with a red flame.

10. Liquid Freon 12 causes eye damage by

    1. a corrosive action.
    2. freezing the eye tissue.
    3. an alkaline reaction.
    4. burning the eye tissue.

11. Breathing refrigerant vapors may cause

    1. vomiting and nausea.
    2. headaches.
    3. fainting.
    4. suffocation.

12. The HIGHEST pressure in the refrigeration cycle is between the

    1. expansion valve and evaporator.
    2. evaporator and compressor.
    3. condenser and expansion valve.
    4. compressor and condenser.

13. Bubbles in the sight gauge indicate

    1. normal operation.
    2. the refrigerant is low.
    3. the compressor pressure is low.
    4. that the expansion valve is sticking.

14. Refrigerant should be added to the system .

    1. at the expansion valve.
    2. at the condenser.
    3. at the compressor high pressure side.
    4. at the compressor suction side.

15. A suction throttling valve is used in some air conditioning systems to

    1. control the expansion valve.
    2. control the compressor cycling.
    3. prevent evaporator freeze-up.
    4. lower the condenser pressure.

16. One of the MOST common faults in servicing an air conditioning system is

    1. using the wrong type refrigerant.
    2. overadjusting the expansion valve.
    3. improper belt installation.
    4. overcharging.

17. The refrigerant supply in the system is stored in the

    1. receiver-dehydrator.
    2. compressor.
    3. condenser.
    4. evaporator.

18. The operation of the magnetic clutch is controlled by

    1. the expansion valve.
    2. a thermostatic switch.
    3. the suction throttling valve.
    4. an electrical relay.

19. The purpose of the receiver-dehydrator is to assure a solid stream of refrigerant to the

    1. evaporator.
    2. suction throttling valve.
    3. expansion valve.
    4. condenser.

20. Refrigerant oil is added to the

    1. evaporator.
    2. condenser.
    3. expansion valve.
    4. compressor.

21. Moisture in the refrigeration system will cause

    1. the expansion valve to freeze.
    2. corrosive acids to form in the evaporator.
    3. compressor lock-up.
    4. condenser inefficiency.

22. When adding refrigerant, the correct level is attained when the

    1. evaporator temperature is 36°.
    2. compressor pressures are to specifications.
    3. sight glass is clear.
    4. expansion valve begins to frost.

23. When charging an evacuated system, the correct amount of refrigerant to be installed is determined by the

    1. air temperature from the evaporator.
    2. pressure at the condenser.
    3. weight of the refrigerant.
    4. ambient temperature.

24. The flame in a torch leak detector, when close to a leak, will turn

    1. orange.
    2. brown.
    3. red.
    4. purple.

25. For evacuating or charging the system, the service valves should be

    1. front-seated.
    2. cracked.
    3. back-seated.
    4. closed.

26. Failure to perform regular maintenance on the ventilating system may cause

    1. the engine temperatures to be too high.
    2. lowered condenser efficiency.
    3. blockage of the heater core.
    4. lowered compressor output.
    5. All of the above

27. PROPER drive belt adjustment is obtained when

    1. the belt can be depressed one inch.
    2. a belt gauge reads the correct specification.
    3. the belt cannot be depressed.
    4. the belt noise is as low as possible.

28. The manifold gauge set is used to

    1. check system pressures.
    2. evacuate the system.
    3. discharge the system.
    4. All of the above

29. When a liquid changes to a vapor the heat transfer involved is called

    1. vaporization heat.
    2. latent heat.
    3. condensation heat.
    4. heat of fusion.

30. The temperature of the coolant passing through the heater core is controlled by the

    1. radiator size.
    2. heater core capacity.
    3. coolant temperature in the radiator.
    4. the thermostat operating range.

31. The principal function of air conditioning systems is to

    1. cool the air.
    2. dehumidify the air.
    3. clean the air.
    4. All of the above

32. The sight glass permits checking the

    1. oil level in the compressor.
    2. level of liquid refrigerant.
    3. refrigerant for icing.
    4. refrigerant vapor.

33. Heater motors are MOST often

    1. connected in series circuit with the ignition switch.
    2. connected in parallel circuit with the ignition switch.
    3. in a separate electrical circuit.
    4. None of the above

In items 34-40 select the proper response from the list of functions A-J appearing to the right of the page which best explains the component. Place your answer choice in the blank to the left of the definition. An answer may be used more than once or not at all.

COMPONENT

___ 34. Compressor
___ 35. Condenser
___ 36. Evaporator
___ 37. Receiver
___ 38. Sight glass
___ 39. Expansion valve
___ 40. Suction throttling valve

FUNCTION

A. Stores liquid refrigerant
B. Controls oil level
C. Compresses Freon vapor
D. Controls evaporator temperature
E. Removes heat from Freon vapor
F. Reduces line vibrations
G. Used to check Freon for bubbles
H. Meters Freon to evaporator
I. Relieves pressure in system
J. Causes cooling by boiling of refrigerant